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Prospective data collection for feeding difficulties and nutrition

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PROSPECTIVE DATA COLLECTION FOR

FEEDING DIFFICULTIES AND NUTRITION

by

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PROSPECTIVE DATA COLLECTION FOR

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ABSTRACT

Introduction: The Boston Children's Hospital Growth and Nutrition Program is a multidisciplinary program focused on assisting babies and children under 6 years of age having problems with feeding and/or weight gain. New patients at the clinic are given questionnaires to complete which provide information on patient demographics, social history, feeding history, etc. The knowledge gained from these questionnaires help identify potential feeding disorders, identify risk factors or causes of malnutrition, and allow for tailored treatment in an individual patient.

Aim: To describe the demographic, social, and clinical characteristics of a sample of patients referred to the Boston Children's Hospital Growth and Nutrition Program while determining whether and how the Growth and Nutrition patient questionnaires should be revised and incorporate validated instruments to track patient feeding, stress, diet and body composition outcomes.

Methods: Examination of 239 patient records from 2015 and 2016 was performed. Data was collected and analyzed from questionnaires completed by guardians or caregivers of the patients, as well as the patients' electronic medical records. Literature review was performed to assess existing feeding assessments as well as mobile intake tracker applications. A review of the mobile intake tracker applications was also performed.

Results: The results of analysis on the patient population at the Boston Children's Hospital Growth and Nutrition Program showed that a majority of patients were White, Non-Hispanic, with private medical insurance and household income of over $60,000 (>60% of recorded patient population for each item). Similar patterns were observed for the rest of the items, with a few exceptions. The Neonatal Eating Assessment Tool (NeoEAT), Pediatric Eating Assessment Tool (Pedi-EAT), and the Child Oral and Motor Proficiency Scale (ChOMPS) feeding assessments had the most justification for use. The mobile applications *Baby Connect* and *MyFitnessPal* had the most desired features for clinical use.

Conclusion: A few items on more specific portions of the questionnaires were deemed unnecessary for further use in the new patient questionnaires, such as having 4th, 5th, and 6th born choices for birth order of the patient (less than 4% of responses chose one of those answers or 'Other'). The Neonatal Eating Assessment Tool (NeoEAT), Pediatric Eating Assessment Tool (Pedi-EAT), and the Child Oral and Motor Proficiency Scale (ChOMPS) feeding assessments are recommended for incorporation and use alongside the new patient questionnaires at the BCH GNP. The currently in use "Behavioral Pediatric Feeding Assessment Scale", or "BPFAS", is not recommended for continued use over the three assessments mentioned above. The mobile applications *Baby Connect* and *MyFitnessPal* are recommended for use in tracking of infant feedings and calories respectively, as the applications possessed the most number of desired features.

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LIST OF ABBREVIATIONS

BCH ....Boston Children's Hospital

BPFAS ....Behavioral Pediatrics Feeding Assessment Scale

BU .... Boston University

CVI...Content Validity Index

GNP.. Growth and Nutrition Program

MeSH .... Medical Subject Headings

PCG...Primary Caregiver

SAM...Severe Acute Malnutrition

SAS ....Statistical Analysis System

SD ....Standard Deviation

SES.. Socioeconomic Status

SNAP ....Supplemental Nutrition Assistance Program

TAFDC ....Transitional Aid to Families with Dependent Children

A. INTRODUCTION

A.1. Childhood Malnutrition and Feeding Skills

a) Malnutrition in Developed Countries

Pediatric malnutrition (undernutrition) is defined as an imbalance between nutrient requirements and intake that results in cumulative deficits of energy, protein, or micronutrients that may negatively impact growth, development, and other relevant outcomes (Mehta et al., 2013). This includes wasting (low weight-for-height), stunting (low height-for-age), and underweight (low weight-for-age). Worldwide, an estimated 178 million children are stunted and 55 million are wasted (WorldHealthOrganization).

Percentiles have been used to rank the position of an individual's measurement (ie. weight, height, etc.) against reference curves that indicate what percentage of the population will be less or greater than that individual. Z-scores describe how far (in standard deviation/SD units) a child's weight or height compares to the mean weight or height at the same height or age in the reference data. The World Health Organization has recommended use of z-scores in expressing malnutrition in the pediatric patient population (Waterlow et al., 1977). The WHO Global Database on Child Growth and Malnutrition uses a z-score cutoff of <-2 SD to classify low weight-for-height, low height-for-age, and low weight-for-age as moderate to severe undernutrition; <-3 SD defines severe undernutrition. Other forms of malnutrition involve micronutrient-related malnutrition (lack of important vitamins and minerals, or excess), as well as overweight and obesity.

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It important to distinguish childhood malnutrition in developing countries as opposed to developed countries due to the difference in etiologies. In developing countries, the majority of cases of childhood malnutrition (z-scores <-1 SD) is related to food insecurity and poverty. In 2008, the World Health Organization estimated that globally, half the cases of children under 5 being classified as underweight or having malnutrition (z-scores <-1 SD) can be attributed to the issue of sanitation including unsafe water and hygiene (Prüss-Üstün, Bos, Gore, & Bartram, 2008). In developed countries, malnourished children are usually secondarily malnourished due to specific, chronic disorders. During the past 3 decades, in developed countries, there has been an increased understanding of how to diagnosis and treat malnutrition (Vaughan & Fuchs, 2015).

Two studies at Boston Children's Hospital estimated the prevalence of hospitalized pediatric patients with acute malnutrition. On a single day in 1976, it was determined that out of the entire inpatient population of Boston Children's Hospital, one-third of all patients exhibited evidence of acute malnutrition (weight for height, <90% of median), and half of patients had chronic malnutrition (height, <95% of median). The assessment was performed again one weekday in September 1992 in order to better understand the effect of medical advances and better nutritional care. In 1992, only a fourth of all patients exhibited evidence of acute malnutrition or chronic malnutrition (Hendricks et al., 1995).

b) *Development of Feeding Skills*

Although eating and swallowing may seem to be a naturally acquired body function, these skills transition from being largely involuntary to having a large voluntary component. Neonatal feeding begins largely as a result of reflexes such as rooting and suckling, and becomes a voluntary act, with only certain parts of the swallowing process being involuntary (Sullivan, 2016). Reau et al. noted that infants and toddlers who take more than 30 minutes to feed are slow feeders, and reports of behavioral feeding problems are common in toddlers, and are related to slow feeding (Reau, Senturia, Lebailly, & Christoffel, 1996). In these cases, further evaluation is considered, including oral, motor, and psychosocial evaluation for possible development of feeding disorders.

One barrier to diagnosing feeding disorders is the lack of consensus on terms or conceptualization to describe pediatric feeding problems across healthcare disciplines (Estrem, Pados, Park, Knafl, & Thoyre, 2017). Reviews of literature on pediatric feeding problems and disorders repeatedly reference this lack of shared conceptualization (Bryant-Waugh, 2013; Davis, Bruce, Cocjin, Mousa, & Hyman, 2010; Lukens & Silverman, 2014; Sharp, Jaquess, Morton, & Herzinger, 2010). There is a general consensus that feeding problems arise when an infant or child is physically unable to eat, or will not enough, despite availability of adequate nutrition (Kedesdy & Budd, 1998). Feeding disorders can manifest as altered appetite, diet, dysphagia, behavior, and oral aversion, and may be more likely to present in children that are susceptible to nutritional impairment. The causes of feeding disorders are summarized in Table 1 (Foy et al., 1997; Illingworth, 1969; Rudolph & Link, 2002).

Table 1. Etiology of Feeding Disorders

Altered appetite	
• Abnormal feeding patterns	
• Supplemental feedings	
• Metabolic disorders	
• Inflammatory bowel disease	

Diet
- Food Allergy
- Inappropriate foods

Dysphagia

- Anatomic:
    - Macroglossia
    - Cleft lip and palate
    - Submucous cleft palate
    - Pierre Robin sequence
    - Laryngeal cleft
    - Tracheoesophageal fistula
    - Esophageal stricture
    - Retropharyngeal mass
    - Vascular ring
    - Foreign body
- Neuromuscular:
    - Prematurity
    - Cerebral palsy
    - Isolated neonatal swallowing dysfunction
    - Bulbar palsy
    - Rett syndrome
    - Infant botulism
    - Muscular dystrophy
    - Pseudo-obstruction
    - Connective tissue disease
    - Repaired tracheoesophageal fistula

- Inflammatory:
    - Viral stomatitis
    - Candida stomatitis, pharyngitis
    - Peptic esophagitis (gastroesophageal reflux)
    - Crohn's Disease
    - Mucositis (graf-versus-host disease)
- Systemic:
    - Cardiac disease
    - Pulmonary disease

Behavioral
- Poor parent-infant interaction
- Autonomy struggles
- Picky eater
- Delayed introduction of solids

Oral aversion
- Conditioned dysphagia
- Post-traumatic eating disorder

Vulnerable child
- Parental responses

Source: Adapted from Rudolph & Link, 2002; Foy et al., 1997; Illingworth, 1969

It can be challenging to determine whether a developing child has a feeding disorder, or whether variations in eating patterns are part of normal development (Patel, 2013). Symptoms and signs of a feeding problem tend to be non-specific, and multiple diagnoses can present with the same symptom(s). Clinicians may be hesitant to provide diagnoses, delayed diagnosis of feeding difficulties can lead to delayed treatment, resulting in malnutrition (Bahr & Johanson, 2013).

As time has passed and medical technology advances, the number of diagnostic definitions of feeding problems has increased (Estrem et al., 2017). Possibilities for this include the fact that with the increasingly sophisticated medical treatments, more of the children and infants are able to survive debilitating diseases (Hendricks et al., 1995). These children can end up developing issues with feeding and subsequently malnutrition. This conclusion coupled with the fact that feeding disorders can be hard to diagnose has necessitated the development of dedicated healthcare professionals and teams devoted to patients with difficulties with feeding. Expert consensus increasingly recognizes multidisciplinary intervention as standard of care for children with complex feeding problems (Lukens & Silverman, 2014; Sharp et al., 2010). A systematic review done by Sharp et. al on existing literature regarding multidisciplinary intervention for pediatric feeding disorders corroborates these claims of positive outcomes associated with multidisciplinary intervention at inpatient and day treatment programs (Sharp, Volkert, Scahill, McCracken, & McElhanon, 2017).

c) *Boston Children's Hospital Growth and Nutrition Program*

Established in 1984, the Growth and Nutrition Program at Boston Children's Hospital was one of the first multidisciplinary team programs in the country devoted to feeding and weight problems in early childhood, specifically in babies and children under the age of 6. The program includes a wide range of healthcare professionals such as gastroenterologists, nurses, registered dieticians, a social worker, behavioral psychologists, and speech (feeding) therapists. An understanding of aggregate data regarding clinical and sociodemographic characteristics of the overall patient population of the clinic would be helpful in driving future patient-related decision making in the clinic. For example, an understanding of the program's patient outcomes would also help reveal areas for potential care improvement. Identification of specific risk factors for malnutrition and/or feeding disorders could help clinicians predict health outcomes and develop targeted interventions.

d) *Clinical History and Feeding Assessment at the Growth and Nutrition Program*

After scheduling an appointment with the department to be completed before the initial visit to the clinic, parents/guardians of a patient at the BCH GNP are sent health and nutrition questionnaires. The purpose of these written questionnaires is to help learn more about the patients' demographics, social history, and feeding history to promote efficient and comprehensive history-taking by clinicians to support accurate diagnosis and treatment.

The current questionnaires in use at the BCH GNP include the 'New Patient Intake' form, the 'Social History' form, and the 'Behavioral Pediatrics Feeding

Assessment Scale', or 'BPFAS'. Both the New Patient Intake and Social History forms were made in-house by the BCH GNP, consisting of items deemed clinically relevant for use with BCH GNP patients.

The New Patient Intake form consists of 45 items covering the patient's contact information, prenatal history, birth history, child medical history, feeding history during first year of life, current feeding practices, family history, and growth and development. Many of the items are multifaceted, with additional questions that must be answered if applicable. Currently the New Patient Intake form is used mostly for clinical purposes in serving to determine diagnostic and therapeutic recommendations while helping to better understand the patients at risk for developing feeding disorders.

The Social History form consists of 20 items covering the patient's demographic information including cultural background, household information, and health program participation. Parents have the right to decline to answer these questions although completion is encouraged, as the data is reported to the Massachusetts Department of Public Health. The purpose of the Social History form is to help identify social risk factors for malnutrition and to identify state programs that may provide helpful resources for the patients' family. Examples of such programs include TAFDC (Transitional Aid to Families with Dependent Children), commonly referred to as welfare, and SNAP (Supplemental Nutrition Assistance Program), commonly referred to as food stamps.

The 'Behavioral Pediatrics Feeding Assessment Scale', or 'BPFAS', was developed by William Crist et al. in order to help assess behaviors associated with poor nutritional intake (William Crist et al., 1994). This validated scale includes 35 items

focusing specifically on refusal to eat, including subsections on child behavior and parental feelings or strategies for dealing with problems. Each item on the scale is rated on a Likert 5-point scale and whether or not the parent considered the item/behavior an issue. The scale is then scored, with higher numbers representing more eating behavior difficulties.

The knowledge gained from these questionnaires help identify potential feeding disorders, identify risk factors or causes of malnutrition, and allow for tailored treatment in an individual patient; aggregate results allow the clinic to identify key risk factors and complications associated with malnutrition or feeding difficulties, helping to target diagnostic testing and treatment interventions.

The current questionnaires have some limitations. First, the assessments are completed by hand. While this method is easy to distribute to families, answer formats cannot be enforced in the same way a web-based questionnaire can be. Some items on the questionnaires require the person filling it out to choose one answer from a list of choices, but it is quite common for parents/guardians to occasionally circle two or more options, which may impair interpretation of those data. Second, the questionnaire is quite lengthy, at 14 pages total.

The goal of the present study is to improve the BCH GNP new patient questionnaires, by making sure that items are clinically relevant and necessary, minimizing patient burden, and utilizing the most efficient and valid feeding assessment tools. A literature review was also conducted to assess the utility of online feeding and calorie trackers for collection of dietary and feeding data.

A.2. Existing Feeding Assessments and Interfaces for Tracking Intake

   a) Existing Feeding Assessments

As part of the goal of improving the assessments, a literature search was performed to review current feeding assessments being offered to similar patient populations in the pediatric outpatient setting. While there are many currently existing feeding assessments available for healthcare professionals to utilize, there is a high amount of variability among them in areas such as target age range for use, length, and readability. The pediatric patient population ranges from newborns to young adults up to 18 years of age. Different age groups have different nutritional requirements as well as feeding behaviors. In an effort to improve upon the efficacy of these questionnaires, the clinic has decided to restructure the assessments in a more systematic and detailed manner.

   b) Psychometric Properties

Psychometric validation can help physicians measure the accuracy and consistency of a tool. Psychometric properties include *validity* and *reliability*. Types of validity include:

- Content validity – whether a tool measures what it is intended to measure (DeVellis, 2011)

- Construct validity – a tool is compared to another theoretically-related measure in order to determine the degree to which a test measures what it claims (Cronbach & Meehl, 1955)

Reliability involves determining whether a tool accurately and consistently measures the construct of interest. Further subtypes of reliability include:

- Internal consistency reliability – correlation between items on a test in measuring the same construct or idea
    - Usually measured by Cronbach's alpha, a statistic calculated from pairwise correlations between items (Knapp, 1991)
- Inter-rater reliability – having consistent results between observers/researchers
- Test-retest reliability – consistency in results overtime (DeVellis, 2011)

The psychometric properties of existing feeding assessments is limited, with some studies not addressing the properties at all (Heckathorn, Speyer, Taylor, & Cordier, 2016). In the publications on assessment tools that account for psychometric properties, the testing usually is not thorough or convincing, and lacking in information regarding the validity and reliability of these assessments. Validity and reliability are important because they demonstrate that a questionnaire or assessment is indeed helpful in not only assisting clinicians in potentially diagnosing feeding disorders but differentiating between patients as well. This leads to clinicians and healthcare professions having an easier time in deciding which feeding assessments to use.

c) *Important Qualities of Feeding Assessments*

After discussion with an attending physician at the BCH GNP, the following properties were chosen for assessing the quality of a feeding assessment: target population, length of the questionnaire, readability, and psychometric properties. Target

population refers to the age group for which the feeding assessments are to be used. As the pediatric patient population covers a large range of ages, questionnaires need to include their intended users. Questionnaire length is an important factor in lessening the respondent burden (the time and effort required to fill out a questionnaire), because shorter questionnaires could encourage higher response rates (Rolstad, Adler, & Ryden, 2011). Readability refers to the ease with which a person can read a given text. Considering that BCH admits a very diverse patient population, having a low readability level for questionnaires can help families who are not able to read or understand more complicated medical terminology. Psychometric properties, as mentioned above, include validity and reliability of a questionnaire.

d) Feeding Trackers

Feeding trackers allow parents to routinely log feedings for their child, write down any notes relevant to their child's feedings, and provide accurate feeding information to healthcare professionals. Currently, parents/guardians of patients at the Growth and Nutrition Program are encouraged to log feeding information by hand. While this method can be useful, it can be hard to enforce in an accessible manner with results reported in a systemic manner that is useful to healthcare professionals immediately i.e. with charts that are automatically produced via the interface. Ideally, the most appropriate application for clinical use would be accessible on various internet enabled personal devices, with the ability to log formula recipes, log feedings for infants, and track caloric

intake. Finally, in terms of utility, an important aspect of a useful application is the ability to track progress over time, and export data to healthcare professionals.

While mobile application use for tracking feedings is an important aspect to explore for clinical use, calorie trackers would also be helpful to facilitate dietary history taking and analysis. The majority of patients have caloric goals that need to be met daily, with breakdowns for specific macromolecules such as carbohydrates and proteins, as well as vitamins.

According to the market research company eMarketer, from 2016 to 2017, the average time adults spent on mobile apps was 3 hours and 23 minutes per day; additionally, only 50 minutes was utilized on mobile web (Lauryn, 2017). As market penetration continues to increase, the number of smartphone users will only grow. These statistics demonstrate an opportunity for the BCH to provide easy alternative methods for parents to track their children's feedings.

Previous results from a study by Boushey et al. concluded that dietary assessment methods using technology, including devices with a camera, were preferred over the pen and paper food record, possibly improving cooperation and accuracy (Boushey et al., 2009). Specifically of interest are mobile applications that allow for logging of baby formula recipes, as the patient population at Boston Children's Hospital often necessitates that specific recipes be used in order to meet the needs of each individual infant patient.

Based on observation of physician and dietician history taking, patient interactions, and discussions with Dr. Susanna Huh, an attending physician and specialist

at the BCH GNP, we examined the following categories of features in existing mobile

applications:

- Record Intake Data

    - Nutrition/Feedings/Calories

- Track Measurements

    - Growth/Weight

- Sharing Data with Healthcare Professional

    - Email

    - CSV (Comma-separated values)

- Consumer Friendly use/user friendly

    - Possibly Economical

- (Bonus) Valid Data in Literature

The "Record Intake Data" category would be the most comprehensive, containing

the subcategories of desired features: ability to track feedings, timer for feedings, notes

sections on feeding entries, a dedicated notes section, and charts available for visual

representation of feeding tracking.

Tracking of feedings is encouraged in order to provide accurate feeding

information to healthcare professionals. The timer allows for parents to keep track of how

long a feeding can take, a potential marker of how well a baby is feeding. The notes

section on feeding entries gives parents the ability to write down any additional concerns

or comments regarding a feeding that can be relayed to clinicians later on. As parents

may need to remember formula recipes specific to their child, having a dedicated notes

section is a desired feature. Charts that track feedings over time can help clinicians look at temporal trends to assess how a patient is responding to therapy, or guide future therapy.

Growth charts plotting weight, height, and head size based on parent entered data can help parents see how their child is doing compared to their expected growth and population reference data. Sharing of patient entered data via csv, html, or pdf allows for ease of access for clinicians to review patient data without having the parent bring in their mobile device to the clinic.

A review of current existing mobile applications for tracking feedings was performed in order to determine if there are any suitable interfaces available that fit the clinic's needs. This included reviewing applications that cover only a subset of desired functionalities. A literature review of mobile applications in use for tracking of infant and pediatric feedings was performed in order to evaluate the current state of research on this topic.

Another google search was performed for mobile applications focused on tracking calories. Alongside the results from the google search, the mobile application "Cronometer" was reviewed, as dieticians in the BCH GNP currently use it in order to track calories and macromolecules. For caloric intake trackers, the following categories of features were examined:

- Food Database
- Barcode Scanner
- Notes Section on Feeding Entry

- Dedicated Notes Section

- Charts/Reports Over Time

With a food database, parents can easily find foods that their child has eaten and log caloric intake and nutritional information. A barcode scanner allows for purchased foods with a barcode to be scanned into the application as a food record with caloric intake and nutritional information. The notes section on feeding entries, same as with a feeding tracker, gives parents the ability to write down any additional concerns or comments regarding a feeding that can be relayed to clinicians later on. A dedicated notes section, same as with a feeding tracker, can help parents remember formula recipes specific to their child. Charts/Reports over time, same as with a feeding tracker, can help clinicians look at trends over time to assess how a patient is responding to therapy, or guide future therapy.

B. SPECIFIC AIMS

1. To describe the demographic, social, and clinical characteristics of patients seeking care at the Boston Children's Hospital Growth and Nutrition Program.

2. To review literature on validated feeding instruments in order to determine how the existing instruments at the Growth and Nutrition Program can be revised or new instruments can be incorporated to help track patient feeding, stress, diet and body composition outcomes.

3. To review the features and feasibility of implementing a mobile application for patient-entered feeding and calorie tracking for patients followed in the Growth and Nutrition Program.

C. METHODS

C.1. Intake Questionnaire

Data Collection of Current New Patient Surveys:

All new patient questionnaires collected during 2014 and 2015 were entered into an electronic REDcap database. Data from scanned copies of new patient intake questionnaires from 2014 and 2015 were de-identified and entered by hand into REDCap. Additional data needed was extracted from patient records in Powerchart when further clarification or verification was needed (such as medicine dosage). Data were analyzed using REDCap and SAS 9.3. We performed a descriptive analysis of patient demographic (i.e. race, socioeconomic status, etc.) and clinical characteristics. We reviewed each questionnaire item and the distribution of response categories to determine whether or not an item yielded valuable clinically-relevant information and/or could discriminate between respondents, in order to determine whether that item should remain in the questionnaire, with the goal of creating a parsimonious questionnaire to minimize respondent burden.

Data variables collected and analyzed included:

1. Medical history of patient and mother. Medical record number, date of birth, gestational age at birth, sex, feeding trends and strategies, etc. collected, with additional EMR chart checks when needed.

2. Social history: patient demographics, as well as socioeconomic status and social services utilized.

3. Behavioral Pediatrics Feeding Assessment Scale (BPFAS), validated

    instrument to assess feeding.

C.2. Literature Review of Feeding Assessments

A literature search was conducted using the PubMed online database for literature

on existing validated instruments for feeding assessments. The PubMed online database

was searched using medical subject headings (MeSH) and full text. The following MeSH

terms were utilized in order to perform the literature search in Pubmed: "Infant feeding"

OR "Children Feeding" AND "Assessment tool." Reference lists of included articles

were also searched for further publications and assessments. Other articles written by

authors of included articles were also searched.

Table 2 below shows the inclusion and exclusion criteria used for selection of

relevant feeding assessments:

Table 2. Inclusion and Exclusion Criteria for Feeding Assessment Literature Search

Inclusion Criteria	Exclusion Criteria
- patients ranging in age from birth to 18 years of age - no specific tools or training required - generic in the sense that the assessments don't only diagnose a specific disorder - can be performed by parents or guardians and not limited to administration by a healthcare professional	- Study population is not human - Assessment requires any sort of instrument - Not published in English - Investigates adult population only - Investigates only for one specific disorder

C.3. Applications Available for Dietary Tracking

For examination of current applications used to track infant feedings, a google search with the terms "infant formula tracker app", "save baby formula recipes app", and "infant feeding app" was performed. As the majority of these applications were phone based, the Apple app store was used to download the applications. Ten viable applications were found and assessed. Only free to use applications were utilized (with the exception of *Cronometer* and *Baby Connect*); applications with in-app purchases were used to the extent that paying was not necessary. As the paid version of *Baby Connect* was used in a peer-reviewed research article, the paid version was also reviewed for use in the BCH GNP (Demirci & Bogen, 2017). A google search was also performed for mobile applications focused on tracking calories. The search terms "caloric intake tracker" and "calorie tracking app" were utilized. The mobile application "*Cronometer*" was also reviewed, as dieticians in the BCH GNP currently use it in order to track calories and macromolecules.

A review of research studies examining the use of mobile applications in use for tracking of infant feedings was performed. A BCH librarian was consulted to conduct a more thorough literature search (search terms provided in APPENDIX A). For the literature search of mobile application use in tracking feeds for children, the following search terms were utilized in PubMed:

- Feeding infant OR Feeding children

AND

- Mobile application

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Applications were ranked based on the amount of features present (total amount of 'x's noted for an application) as shown in Tables 15 and 18 on interfaces for tracking intake and calories respectively.

D. RESULTS

D.1. Analysis of Intake Questionnaire Data: Patient Characteristics

Demographics and Social History (Tables 3 and 4)

The majority of patients are White, Non-Hispanic, with private medical insurance and household income of over $60,000. Over 80% of the maternal and paternal relationships were classified as biological parents. A higher percentage of maternal guardians listed "4 years of college or more" as their highest education (around 70%) compared to paternal guardians (around 65%), but a higher number of paternal guardians work full-time outside the house (around 76%) compared to maternal guardians (around 36%). Over 70% of patient families did not participate in any Health Programs (except Early Intervention with around 57% of patient families not participating). Over 90% of parents noted that the patient is not and has not in the past year been homeless. Over 90% of parents also noted that the patient is not and has not been in foster care in the past year. Over 70% of responses were "Enough and the kinds of foods wanted" for the item "What best describes the food eaten in child household in last 12 months".

Table 3. Patient Demographics (N=239)

Characteristic	N (%)
Sex:	
Male	148 (61.9)
Female	91 (38.1)
Race:	
White	177 (74.1)
Asian	33 (13.8)
Black, African American	18 (7.5)
American Indian/Alaskan Native	4 (1.7)
Native Hawaiian/Other Pacific Islander	0 (0)
Other	21 (8.8)
Ethnicity:	
Non-Hispanic	199 (83.3)
Hispanic	21 (8.8)
Unknown	19 (8.0)
Insurance:	
Private Insurance	167 (69.9)
Medicaid/Mass Health	54 (22.6)
Commonwealth Care/Health Safety Net	2 (0.8)
Other	16 (6.8)
Household Income (past 12 months):	
0-19,999	17 (7.1)
20,000-29,999	12 (5.0)
30,000-59,999	27 (11.4)
>60,000	155 (64.9)
Unknown	28 (11.7)
Housing Status:	
Child been homeless in the past year	4 (1.7)
Child currently homeless	1 (0.4)
Child been in foster care in the past year	3 (1.3)
Child currently in foster care	2 (0.8)
Child household participation in healthcare programs:	
Early Intervention	71 (29.7)
WIC	29 (12.1)
SNAP (food stamps)	27 (11.3)
SSI	13 (5.4)
Transitional Aid to Families with Dependent Children (TAFDC)	4 (1.7)
DCF	3 (1.3)
Head Start	3 (1.3)
If yes for TAFDC, was child or a sibling a TAFDC Family Cap Child	1 (2.0)
Adolescent Parenting Program	0 (0.0)
Other	4 (1.7)

Table 4. Household Information (N=239)

Characteristic	N (%)
Maternal Relationship:	
Biological parent	214 (89.5)
Legal guardian	10 (4.2)
Unknown	15 (6.3)
Maternal Guardian Last Completed Education:	
4 years college or more	168 (70.3)
Some college	37 (15.5)
Finished high school/GED	14 (5.9)
Some high school	7 (2.9)
Less than high school	2 (0.8)
Unknown	11 (4.6)
Maternal Guardian Employment:	
Full-time, outside home	87 (36.4)
Full-time, homemaker	55 (23.0)
Part-timer	44 (18.4)
Full-time, in the home (not homemaker)	16 (6.7)
Unemployed	13 (5.4)
Student (not employed)	5 (2.1)
Parental Leave	3 (1.3)
Other	16 (6.7)
Paternal Relationship:	
Biological parent	193 (80.8)
Legal guardian	15 (6.3)
Unknown	31 (13.0)
Paternal Guardian Last Completed Education:	
4 years college or more	157 (65.7)
Some college	25 (10.5)
Finished high school/GED	26 (10.9)
Some high school	7 (2.9)
Less than high school	2 (0.8)
Unknown	22 (9.2)
Paternal Guardian Employment:	
Full-time, outside home	183 (76.6)
Unemployed	9 (3.8)
Full-time, in the home (not homemaker)	5 (2.1)
Student (not employed)	5 (2.1)
Part-timer	4 (1.7)
Parental Leave	3 (1.3)
Full-time, homemaker	1 (0.4)
Other	29 (12.1)
What best describes the food eaten in child household in last 12 months:	
Enough and the kinds of foods wanted	171 (71.5)
Enough but not always the kinds of food wanted	23 (9.6)
Sometimes not enough food	11 (4.6)
Often not enough food	11 (4.6)
Refused to answer	0 (0.0)
Unknown	23 (9.6)

Birth History (Table 5)

Around 30% of patient families reported problems during childbirth.

Table 5. Birth History (N=239)

Characteristic	N (%)
Birth order of child to biological mother:	
1st born	111 (46.4)
2nd born	84 (35.2)
3rd born	24 (10.0)
Other	9 (3.8)
Unknown	11 (4.6)
Problems During Childbirth:	
Yes	73 (30.5)
No	159 (66.5)
Unknown	7 (2.9)
Gestational Age at Birth:	
<28 weeks	46 (20.0)
28 to <34 weeks	7 (3.0)
34 to <37 weeks	17 (7.4)
>=37 weeks	160 (69.6)

Dietary Data (Tables 6 and 7)

Over 80% of parents noted giving breast milk during first year of life, both fed and expressed. Over 80% of parents noted using formula during the first year of life as well. Over 70% of children were given solid foods between 4 to 8 months of age. A majority of patients (~60%) visiting the BCH GNP clinic were given formula/supplement in the past month. Over 60% of patients did not drink rice or soy milk; over 60% of patients also did not soda or other sweetened beverages.

Table 6. Breast Milk, Formula Feeding, and Solid Foods (N=239)

Characteristic	N (%)
Breast milk given during 1st year of life:	
Yes	199 (84.7)
No	36 (15.3)
Of those given breast milk, how was it given:	
BOTH fed at the breast & expressed breast milk	128 (64.3)
ONLY fed at the breast	41 (20.6)
ONLY expressed breast milk	30 (15.1)
Best describes child's feeding:	
Mostly fed at the breast	50 (39.1)
50% fed at the breast & 50% expressed breast milk	39 (30.5)
Mostly expressed breast milk	27 (21.1)
Unknown	12 (9.4)
Formula given during 1st year of life:	
Yes	189 (80.1)
No	47 (19.9)
How formula was given:	
Bottle	174 (72.8)
NG-tube	15 (6.3)
G-tube	9 (3.8)
J-tube	0 (0)
Other	10 (4.2)
When was solid foods first given during 1st year of life:	
My child did not eat solid food during 1st year of life	3 (1.3)
Less than 4 months	8 (3.4)
4 to 6 months	98 (41.0)
6.1 to 8 months	85 (33.4)
9 months or older	18 (7.5)
Unknown	27 (11.3)

Table 7. Liquid Foods (N=239)

Characteristic			N (%)		
On average, in the past month, how much liquid did your child get per day (1 day = 24 hrs):	**None**	**0-7oz**	**8-15oz**	**16-23oz**	**24+oz**
Breast Milk	127 (53.1)	9 (3.8)	6 (2.5)	17 (7.1)	11 (4.6)
Cows Milk (including flavored milks)	73 (30.5)	28 (11.7)	43 (18.0)	36 (15.1)	15 (6.3)
Rice or soy milk	147 (61.5)	9 (3.8)	5 (2.1)	3 (1.3)	4 (1.7)
Almond milk	12 (5.7)	5 (2.4)	0 (0.0)	0 (0.0)	0 (0.0)
Water	25 (10.5)	88 (36.8)	54 (22.6)	19 (7.9)	10 (4.2)
Juice/Fruit Drink	79 (33.1)	73 (30.5)	19 (7.9)	7 (2.9)	3 (1.3)
Soda or other sweetened beverages	156 (65.3)	11 (4.6)	1 (0.4)	1 (0.4)	0 (0.0)
Formula/Supplement	98 (41.0)	21 (8.8)	27 (11.3)	19 (8.0)	23 (9.6)

Feeding Behavior (Tables 8 and 9)

Around 50% of parents noted that they "Strongly Disagreed" with the statement "My child will eat almost anything." The choice "Never" for the "Feed when falling asleep or asleep (dream feed)" item was chosen around 72% of the time. Also the "Never" choice for the "Punish" item was chosen around 80% of the time.

Table 8. Mealtime Behavior (N=229)

Characteristic	N (%)			
In the past month, during mealtime:	Strongly Disagree	Disagree	Agree	Strongly Agree
My child does not trust new foods	27 (11.8)	41 (17.9)	70 (30.6)	24 (10.5)
If my child does not know what a food is s/he will not try it	22 (9.6)	66 (28.8)	57 (24.9)	61 (26.6)
My child is afraid to eat things s/he has never tried before	29 (12.7)	61 (26.6)	59 (25.8)	53 (23.1)
My child will eat almost anything	117 (51.1)	46 (20.1)	30 (13.1)	13 (5.7)
My child is very particular about the foods s/he will eat	15 (6.6)	32 (14.0)	64 (28.1)	92 (40.4)
My child is constantly sampling new and different foods	88 (38.4)	58 (25.3)	42 (18.3)	14 (6.1)
My child refused to eat	24 (10.5)	52 (22.7)	81 (35.4)	45 (19.7)
My child threw food/utensils	60 (26.2)	68 (29.7)	44 (19.2)	26 (11.4)
My child only ate foods that were certain brands or packages	73 (31.9)	74 (32.3)	36 (15.7)	18 (7.9)
My child refused foods that were certain textures (eg. crunchy, dry, smooth, chewy)	34 (14.9)	51 (22.3)	65 (28.4)	47 (20.5)
My child only ate foods that were specific colors (eg. brown)	84 (36.7)	98 (42.8)	11 (4.8)	8 (3.5)
My child gagged or vomited when new foods were given	56 (24.7)	65 (28.6)	52 (22.9)	25 (11.0)

Table 9. Caregiver Strategies (N=239)

Characteristic	N (%)		
In the past month, caretaker ever used any of the following strategies to increase child food/liquid intake:	**Never**	**Sometimes**	**Often**
Praise	17 (7.1)	47 (19.7)	142 (59.4)
Offer reward	84 (35.2)	62 (25.9)	62 (25.9)
Offer only foods my child likes	26 (10.9)	71 (29.7)	112 (46.9)
Offer small amounts often	34 (14.2)	99 (41.4)	81 (33.9)
Let my child to snack whenever they want	71 (29.7)	83 (34.7)	49 (20.5)
Feed in front of television or electronic devices (eg. iPad)	77 (32.2)	86 (36.0)	48 (20.1)
Distract with toys	109 (45.6)	66 (27.62)	38 (15.90)
Feed when falling asleep or asleep (dream feed)	172 (72.0)	23 (9.6)	18 (17.5)
Syringe or spoon feed	105 (43.9)	56 (23.4)	44 (18.4)
Send to room for time out	6 (2.5)	3 (1.3)	0 (0.0)
Punish	187 (78.2)	20 (8.4)	3 (1.3)
Ignore	147 (61.5)	57 (23.9)	4 (1.7)

Family History (Table 10)

For both mothers and fathers, the most common family history diagnosis was allergies, with around 33% of patient households reported having a father with food or environmental allergies, and around 40% of patient households reported having food or environmental allergies. Depression and anxiety were the next most common diagnoses in mothers, with 15% of patient households noting a mother with depression and 19% noted anxiety. These percentages are around 3 times the percentages of fathers noted with the same diagnoses of depression and anxiety at 5% and a little less than 7% respectively. Three patient families noted a mother with a diagnosed eating disorder, and no patient households noted that a father had an eating disorder. Almost 10% of patient households noted that extended family had substance abuse problems; less than 3% of patient households said that the mother or father of the patient had the same issues. Around 10% of patient households noted that extended family had celiac disease; less than 2% of patient households said that the mother, family, or brothers/sisters had celiac disease.

Table 10. Family History (N=239)

Characteristic	N (%)			
Conditions diagnosed in family:	Mother	Father	Brothers/Sisters	Extended Family
Food allergies	39 (16.3)	24 (10.0)	32 (13.4)	35 (14.6)
Environmental Allergies	59 (24.7)	56 (23.4)	25 (10.5)	28 (11.7)
Celiac (Sprue Disease)	1 (0.4)	3 (1.3)	1 (0.4)	11 (4.6)
Eating Disorder	3 (1.3)	0 (0.0)	1 (0.4)	5 (2.1)
Feeding Problems	14 (5.9)	13 (5.4)	16 (6.7)	13 (5.4)
Gastroesophageal Reflux	23 (9.6)	13 (5.4)	17 (7.1)	29 (12.1)
Depression	36 (15.1)	12 (5.0)	4 (1.7)	37 (15.5)
Anxiety	45 (18.8)	16 (6.7)	10 (4.2)	33 (13.8)
Substance Abuse	3 (1.3)	6 (2.5)	0 (0.0)	23 (9.6)

D.2. Literature Review of Valid Instruments for Pediatric Feeding Assessment

The review of current literature regarding pediatric feeding assessment instruments returned 9 results after applying inclusion and exclusion criteria. The results are summarized in Table 11 for infant feeding assessments and Table 12 for child feeding assessments. The tables are organized based on target population age with younger target populations at the top. The Neonatal Eating Assessment Tool (NeoEAT), the Pediatric Eating Assessment Tool (Pedi-EAT), and the Child Oral and Motor Proficiency Scale (ChOMPS) had themost strengths noted. For the general pediatric population, only 3 validated instruments were identified, with 1 instrument having a target population that goes up to 18 years of age. A double asterisk (**) signifies that an infant feeding assessment could also be used for general pediatric use.

Table 11. Current Infant Feeding Assessments

Study	Target Population	Length	Readability	Validity & Reliability	Pros/Cons
(Pados, Estrem, Thoyre, Park, & McComish, 2017) *Neonatal Network* **The Neonatal Eating Assessment Tool (NeoEAT): Development & Content Validation**	Infants 0-6 months old.	NeoEAT: Breast-feeding – 72 items NeoEAT: Bottle-feeding – 74 items NeoEAT: Breast- and Bottle-feeding – 89 items *no reporting on how long assessments take	NeoEAT: Breast-feeding – 5.1 NeoEAT: Bottle-feeding – 5.1 NeoEAT: Breast- and Bottle-feeding – 5.3	Content Validity 19 items had item-level CVI <.78 57 items retained, 38 revised, 31 deleted, 2 added Reliability: No reporting of reliability	· (+) Good content validity testing · (+) Readability levels low · (+) Different versions depending on bottle- or breast- feeding · (-) No reporting of reliability
(Thoyre et al., 2014) *American Journal of Speech-Language Pathology* **Development and Content Validation of the Pediatric Eating Assessment Tool (Pedi-EAT) **	Children ages 6 months and older and currently being offered solid foods *Upper range not specified	97 item questionnaire, average length of time to complete for 20 parents was 16 minutes	Less than 5th grade	Content Validity: Experts rated the total scale CVI > .90 for both relevance and clarity; item CVI ranged from .67 to 1.0 for relevance and .5 to 1.0 for clarity. Reliability: No reporting of reliability	· (+) Readability is low · (+) Solid evidence for content validity · (+) Does not mention upper limit on age · (-) No reporting of reliability
(Matthews, 1988) *Midwifery* **Developing an instrument to assess infant breastfeeding behavior in the early neonatal period** ***IBFAT**	Newborn babies from birth to 4 days after birth	Four items, reported to be completed in less than 1 minute	No reporting on readability *reported to be easy to use	Content Validity: Evidence of content validity through expert feedback, but no testing Reliability: Good internal reliability for the final 4-item BBAT. (Cronbach's alpha = 0.668) High correlation in consistency of use by the seven midwives (ICC=0.782)	· (+) Reportedly quick and easy to use · (+) Decent inter-rater reliability · (-) No testing of content validity · (-) Study only includes fairly small number of multiple comparisons between midwives · (-) Narrow target age range used for testing

(Nyqvist, Rubertsson, Ewald, & Sjoden, 1996) *Journal of Human Lactation* **Development of the preterm infant breastfeeding behavior scale (PIBBS): A study of Nurse-Mother Agreement**	Hospitalized preterm infants	6 items: Rooting, Areolar grasp, latching-on, sucking, swallowing, letdown/milk ejection reflex. *no reporting on how long assessment takes	No reporting on readability	Content Validity: Evidence of content validity through expert feedback, but no testing Reliability: Inconsistent interrater reliability, with kappa values mostly below .50 between observers and mothers	· (-) Complicated assessment · (-) No testing of content validity · (-) Inconsistent reliability · (-) Observing feedings can take a while
(Park, Pados, Thoyre, Estrem, & McComish, 2016) *(Poster)* **Development and Assessment of Psychometric Properties of the Child Oral and Motor Proficiency Scale (ChOMPS)** **	Children 6 mos to 7 yrs	63 items consisting of 4 subscales *no reporting on how long assessment takes	Readability acceptable at <6th grade level	Content Validity: Scale-level CVI was acceptable both for relevance (.96) and clarity (.90). Reliability: Strong internal consistency reliability: Complex movement patterns Cronbach's α: 0.971 Basic movement patterns Cronbach's α: 0.941 Oral-motor coordination Cronbach's α: 0.934 Fundamental Oral-motor skills Cronbach's α: 0.735	· (+) Good content validity testing · (+) Good internal consistency · (+) Readability levels low · (-) Not peer-reviewed
(W. Crist & Napier-Phillips, 2001) *Developmental and Behavioral Pediatrics* **Mealtime Behaviors of Young Children: A Comparison of Normative and Clinical Data** *BPFAS **	Healthy children between the ages of 9 months and 7 years	35 items 25 items on child behavior 10 items on parent's feelings about or strategies for dealing with eating problems *no reporting on how long assessment takes	No reporting on readability	Content Validity: Evidence of content validity, but no testing Reliability: Decent test-retest reliability of BPFAS: scores from child and parent section of BPFAS for first and second administration were significantly correlated (for total score, r =0.85, p < 0.001; for child score, r = 0.82, p < 0.001; for parent section, r = 0.83, p < 0.001	· (+) Decent reliability · (+) Easy to complete · (-) No reporting on readability · (-) No reporting on content validity testing

Table 12. Current Pediatric Feeding Assessments

Study and Objective	Target Population	Length	Readability	Content Validity & Reliability	Justification
(Wardle, Guthrie, Sanderson, & Rapoport, 2001) *Journal of Child Psychology and Psychiatry* **Development of the Children's Eating Behaviour Questionnaire** *CEBQ	Children 2-9 years old	35-item instrument with eight scales *no reporting on how long assessment takes	No reporting on readability	Content Validity: Internal validity, but no testing Reliability: Test-retest reliability was high for all scales except the two emotional eating scales, which had reliabilities of .52 and .64.	· (-) Inconsistent reliability · (-) No content validity testing · (-) No reporting of readability
(Hendy, Williams, Camise, Eckman, & Hedemann, 2009) *Appetite* **The Parent Mealtime Action Scale (PMAS). Development and association with children's diet and weight**	School age children from 1st to 4th grade	31-item instrument *no reporting on how long assessment takes	No reporting on readability	Convergent Validity: The mean Pearson coefficient for **convergent** validity for the nine PMAS dimensions was .69 (.59–.78). Reliability: Internal: The mean Cronbach's alpha for the nine PMAS dimensions was .62(.42-.81). The mean test-retest reliability for the nine PMAS dimensions was .62 (.51-.75).	· (+) Decent convergent validity · (+) Good internal and test-retest reliability · (-) No reporting of content validity · (-) No reporting on readability · (-) Limited target age range
(Seiverling, Hendy, & Williams, 2011) *Research in Developmental Disabilities* **The Screening Tool of Feed-ing Problems applied to children (STEP-CHILD): Psychometric characteristics and associations with child and parent variables**	Children ranged in age from 24 months to 18 years.	15-item assessment with six subscales of child feeding problems *no reporting on how long the assessment takes	No reporting on readability	Convergent Validity: **Convergent validity** STEP-CHILD subscales were validly measuring the underlying variables described by their names with all p=.000 in positive subscale correlations Mean convergent validity coeff. .69 Reliability: No reporting on reliability	· (+) Good convergent validity · (-) No reporting on reliability · (-) No reporting on content validity · (-) No reporting on readability

D.3. Current Feeding and Caloric Intake Trackers

The google search for mobile applications for use in tracking of feedings returned 9 results after filtering for the desired features. Table 13 shows the results of analysis of the applications on the desired features for the category "Record Intake Data." The rest of the categories of desired features were assessed, with results shown in Table 14. Combining the results of these two tables for representation of all categories of desired features is shown in Table 15. Applications with a single asterisk (*) next to the name are applications that require an upfront payment for use. A double asterisk (**) next to the name represents an app that is free to use, but has some features that require payment for full access. For applications that are free to use, with features that require payment for use are denoted with a cross (†) next to an x.

Table 13. Desired Functions for Recording Intake Data

Application	Track Feedings	Timer			Notes section on feeding entry	Dedicated Notes Section	Charts tracking feedings
		Breast-feeding	Bottle	Solid			
Baby Connect* (Seacloud)	x	x	x	x	x	x	x
FeedBaby** (PENGUIN)	x	x	x[†]	x[†]	x	x	x[†]
Babynursing (Sevenlogics)	x	x			x	x	x
Sprout Baby (MedART)	x	x	x		x		
ParentLove (Coquisoft)	x	x			x		x
WebMD Baby (WebMD)	x	x			x	x	
BabyFeedingLog (Beaver)	x	x	x				
Baby Tracker** (Nighp)	x				x		x[†]
Glow Baby (Glow)	x	x					x

Table 14. Other Categories of Desired Features for Interfaces for Tracking Intake

Application	Track Measurements: Growth/Weight Charts			Sharing Data			Consumer/ User Friendly		Valid Data in Litera-ture
	Weight	Height	Head Size	csv	html	pdf	Easy to Use	Cost for premium features	
Baby Connect* (Seacloud)	x	x	x	x	x		x	$4.99	x
FeedBaby** (PENGUIN)	x	x	x	x†			x	$8.55	x
Glow Baby (Glow)	x	x	x			x	x	$7.99/mo $3.99/yr $59.99/life-time	
Babynursing (Sevenlogics)	x	x	x	x	x			$4.99	
Sprout Baby (MedART)	x	x	x			x		$4.99	
ParentLove (Coquisoft)	x	x	x				x	free	
WebMD Baby (WebMD)	x	x	x				x	free	
BabyFeedingLog (Beaver)				x			x	$0.99	
Baby Tracker (Nighp)				x				$4.99	

Table 15. All Categories of Features Desired for Interfaces for Tracking Intake

Application	Record intake data	Track measurements	Share data	Consumer/user friendly	(bonus) valid data in literature
Baby Connect* (Seacloud)	x 7/7	x 3/3	x 2/3	x $4.99	x
FeedBaby** (PENGUIN)	x[†] 7/7	x 3/3	x[†] 1/3	x $8.55	x
Babynursing (Sevenlogics)	x 5/7	x 3/3	x 2/3	$4.99	
ParentLove (Coquisoft)	x 4/7	x 3/3		x free	
WebMD Baby (WebMD)	x 4/7	x 3/3		x free	
Sprout Baby (MedART)	x 4/7	x 3/3	x 1/3	$4.99	
Glow Baby (Glow)	x 3/7	x 3/3	x 1/3	x $7.99/mo $3.99/yr $59.99/life-time	
BabyFeedingLog (Beaver)	x 3/7		x 1/3	x $0.99	
Baby Tracker** (Nighp)	x[†] 3/7		x 1/3	$4.99	

Overall, _Feedbaby_ and *Baby Connect* were the applications that had the most desired features available. These two applications both have all the features desired for recording intake data, allow for tracking of measurements, and allow for sharing of data. *Feedbaby* can only can only share data through a csv file export, while *Baby Connect* allows for data sharing through csv and html exports.

The review of current literature regarding current infant feeding trackers returned 2 results, 1 with librarian assistance. The results are summarized in Table 16. For general pediatric feeding trackers, a total of 3 articles were found. The results were summarized in Table 17.

Table 16. Literature on Mobile Application Use for Infant Feeding Tracking

Study and Objective	Application	Use	Data Abstracted	Findings
(Demirci & Bogen, 2017) *Journal of Human Lactation* **An Ecological Momentary Assessment of Primiparous Women's Breastfeeding Behavior and Problems From Birth to 8 Weeks** **Objective:** Describe breast-feeding behaviors of first-time mothers via a mobile-feeding application.	Baby Connect	**Track feeding and milk expression data** as close as possible to the time it occurred. Also encouraged participants to freetext their breastfeeding thoughts and experiences daily or at least once per week using the app diary. Women sent their app data daily or weekly through 8 weeks via email summary feature (HTML format)	· Daily number of at-breast feeds · Formula feeds · Milk expressions · Daily volumes of formula and milk expressed and/or provided to infant · Current breastfeeding problems · Reasons for formula use	**Data Extrapolation:** Hard to determine whether missing data represented a logging omission or infrequent feeds. Data likely an underrepresentation of formula use, breastfeeding problems, and breastfeeding cessation rates among primiparous women intending to exclusively breastfeed. · App is paid · Socioeconomic barriers
(Chaudhry, 2016) *Mhealth* **Baby statistics: there is an App for that!** *review	Feed Baby	Track baby's health data	· Medications · Diaper · Feeding · Weight · Length · etc.	Case report documents features of app on a surface level, does not note any limitations. -allows for parents and pediatricians to see if baby is sleeping enough, eating enough and following normal development.

Table 17. Literature on Mobile Application Use for Child Feeding Tracking

Study and Objective	Application	Use	Data Abstracted	Findings
(Hull et al., 2017) *JMR Mhealth Uhealth* **A Smartphone App for Families With Preschool-Aged Children in a Public Nutrition Program: Prototype Development and Beta-Testing** **Objective:** Describe the development and beta-testing of the CHEW smartphone app.	CHEW	CHEW app consisted of WIC Shopping Tools, **including barcode scanner and calculator tools for the cash value voucher for purchasing fruits and vegetables**, and **nutrition education** focused on healthy snacks and beverages, including a Yummy Snack Gallery and Healthy Snacking Tips	· Time-stamped notations when certain activities or events performed by the user, such as opening the app or one of the features, into an archived file · Frequency and duration of app sessions · Frequency of using app features	Reasons for not using a specific app feature at all: · Technical barriers ie. broken phone, unsuccessful installation · App not easy to use · Lack of interest in content · Forgetting to use · Not noticing alerts Challenge of programming apps on the Android platform. **Limitations:** Survey responses of can be influenced by social desirability bias. Did not have mechanism to automatically download extensive app usage data directly from all the participants due to budget constraints
(Six et al., 2010) *Journal of the American Dietetic Association* **Evidence-based development of a mobile telephone food record** **Objective:** (1) to test proficiency with the mobile telephone food record (mpFR) after training and repeated use, and (2) to measure changes in perceptions regarding use of the mpFR	Mobile telephone food record	Use mobile telephones to collect dietary information that reduces burden on record keepers and would be of value to practicing dieticians and researchers. Image sent back to user for user to confirm foods identified correctly. Info from image analysis and volume estimation can be linked to a nutrient database to estimate energy and nutrients consumed. Then nutrient analysis can be sent to healthcare professions.	· Pictures of food before and after eating · Metadata including time stamp and digital codes	Need an object of known dimensions and markings, referred to as a *fiducial marker*, to be used as a reference Software easy to use. **Limitations:** Challenge to include all items in image. Have to include photo of completely empty plates and glasses if ate all food/beverages

(Aflague et al., 2015) *Nutrients* **Feasibility of Use of the Mobile Food Record for Capturing Eating Occasions among Children Ages 3-10 Years in Guam** **Objective:** Determine if children 3-10 years could successfully use the mobile food record (mFR) to capture an image pair of one eating occasion	Mobile food record (mFR)	mFR is a dietary record application that **uses the embedded camera in a mobile device to record dietary intake**	· Provide primary record of dietary intake to obtain valid estimates of energy intake · Methods of automated image analysis or a trained analyst can be used to identify the food in the image and estimate volume of food consumed	Children were given freedom to manage and store mobile devices where they pleased => every mobile device was returned undamaged which demonstrates that even very young children can be responsible for these devices Attentiveness can be another challenge to remembering to take the after eating image or any image for that matter Enhancements to any technology assisted dietary assessment should be designed to be age appropriate in that cognitive abilities, such as literacy level needs to be addressed for children in early childhood Short-statured children often observed standing, tip-toeing, or kneeling on a chair to capture best image.

The google search for mobile applications for use in tracking of intake calories returned 5 results. This includes the mobile application *Cronometer*, which is already in use at the BCH GNP by certain dieticians. The results are summarized in Table 18. The results of a review of *Cronometer* are summarized in Table 19.

Table 18. General Caloric Intake Trackers

Application	Food database	Barcode Scanner	Notes section on feeding entry	Dedicated notes section	Charts/Reports over time	Additional comments
MyFitnessPal (MyFitnessPal)	x	x	x	x	x	Can add note to daily log
Fooducate (Fooducate)	x	x	x	x	x	Interface not too intuitive
MyNetDiary (MyNetDiary)	x	x			x	Nice visuals to help track calorie intake and goals
My Diet Diary (StayWell)	x	x	x		x	Interface not too intuitive
Cronometer (Cronometer)	x	x			x	Can add foods/recipes with custom nutritional values

Table 19. Advantages and Disadvantages of Cronometer

PROS	CONS
• Already used by Boston Children's employees • Allows for custom recipes in which you can add ingredients from a food database with stored nutritional info • Can add new foods to personal database with custom nutritional information • Has charts/informational reports • (Paid) Oracle function lists foods that are best sources for a chosen nutrient • (Paid) Can share all custom foods/recipes with 'friends' • (Paid) Can request monitoring of your nutritional data by a Health and Fitness professional that uses Cronometer	• Requires subscription/paid membership for sharing options • No notes section per food entry • No dedicated notes section • No way to export data directly ie. via email or csv

E. DISCUSSION

This study sought to the describe the demographic, social, and clinical characteristics of patients seeking care at the Boston Children's Hospital Growth and Nutrition Program while also determining how to best improve the questionnaires given to new patients in order to best serve the clinic.

E.1. Boston Children's Hospital Growth and Nutrition Program Patient Characteristics

The majority of patients are of White race, were from households with an annual income over $60,000 and had private medical insurance. A majority of parents noted that in the past 12 months, the patient's family household described the foods eaten as "enough and the kinds of foods wanted," which taken together with the socioeconomic characteristics suggest that lack of access to food was not a major risk factor for feeding difficulties or malnutrition in this patient population. Praise was the most common caretaker strategy utilized in increasing child food/liquid intake, with negative strategies such as punishment and seldom utilized.

Food allergies are somewhat prevalent, with over 10% of responses noting a mother, father, brother/sister, or extended family with food allergies. Comparatively, a randomized survey given to US households with children from June 2009 to February 2010 found that food allergy prevalence was 8.0% within this population (Gupta et al., 2011). Some data suggest that the prevalence of food allergies is more prominent in populations with feeding difficulties (Yeung et al., 2015), perhaps because food allergies

can cause children to decline certain foods. Almost a quarter of all mothers and fathers of patients had environmental allergies. Further analysis on the kinds of environmental allergies that are prevalent could help identify risk factors associated with feeding disorders.

The majority of GNP patients did not use social assistance programs, with Early Intervention having the highest participation at less than a third of patient families reporting participation. Early Intervention is a program focused on helping infants and toddlers (up to 3 years of age) with developmental delays or that are at risk for developmental delays (EarlyIntervention). The finding that the social assistance program with the highest percentage of participation being Early Intervention is unsurprising, as early development of sucking and subsequently oral motor development depends in part on physiological and mental maturation (Sullivan, 2016) so patients with developmental delays may be more likely to have feeding disorders.

Suggested Modifications of the Existing New Patient Intake Questionnaire

Of the items listed in Table 3 on patient demographics, out of 239 responses, none of reviewed patients chose "Native Hawaiian/Other Pacific Islander" for "Race", and only 2 chose "Commonwealth Care/Health Safety Net" for "Insurance". Recommendations for improvement of these questions include removal of the answer choices and being part of the "Other" answer choice. The choices "DCF", "Head Start", "Adolescent Parenting", and "TAFDC" and its child question should be removed, and instead put under the "Other" choice as the choices were each chosen less than 4 times.

Over 90% of responses noted that the patient is not and has not in the past year been homeless. The same statistic is true for foster care. These questions should be removed due to the high likelihood of the similar statistics going forward. For items regarding "Birth History" under Table 5, the answer choices "28 to <34 weeks" and "34 to <37 weeks" should be combined into one answer choice of "28 to <37 weeks" for the "Gestational Age at Birth" item (both answer choices less than 10% of responses). From preliminary analysis of the REDcap data, it was decided that the original choices "4th born", "5th born", and "6th born" would be removed and instead classified under the "Other" choice for the "Birth order of child to biological mother" item. For the "Breast Milk, Formula Feeding, and Solid Foods" items in Table 6, recommendations include removing the "J-tube" answer choice from the "How formula was given" item. For the "Family History" items in Table 10, recommendations include removing the "Eating Disorder" item, as each answer choice for family members was less than 3% of the total responses.

E.2. Feeding Assessments

Concerning current feeding assessments available for infants, a few questionnaires are recommended for various reasons. The Neonatal Eating Assessment Tool (NeoEAT) for infants 0-6 months old is recommended, due to its content validity testing, low readability levels, and options available for bottle/beast-feeding/both assessments. The questionnaire is limited in the fact that there was no reporting on reliability. The Pediatric Eating Assessment Tool (Pedi-EAT) for children from 6 months

of age and older is recommended due to its content validity testing, low readability levels, and wide age range. For Pedi-EAT, there is no upper ceiling on the intended age range for usage; this is helpful in that a majority of pediatric patients at the BCH GNP can use it. The questionnaire is limited in the fact that there was no reporting on reliability. Lastly, the Child Oral and Motor Proficiency Scale (ChOMPS) for children 6 months to 7 years of age has good content validity testing, good internal consistency, and low readability levels. The questionnaire is not peer-reviewed, so its use in the clinic should be held off until peer-reviewed. While the NeoEAT, Pedi-EAT, and ChOMPS are recommended for use, the questionnaires are each over 60 items long, potentially increasing response burden compared to the 35 item BPFAS (Behavioral Pediatric Feeding Assessment Scale) currently in use.

The BPFAS, currently in use at the BCH GNP, has decent reliability (reliability coefficients over 0.80 for each subsection) and is reportedly easy to complete. However, there is no reporting on readability, with some evidence of content validity but no testing. Because of the lack of psychometric properties research on this tool, the NeoEAT, Pedi-EAT, and ChOMPS are still recommended for use over the BPFAS, despite potentially increased response burden.

For the general pediatric population, none of the assessments reviewed in Table 12 are recommended. The CEBQ (Children's Eating Behaviour Questionnaire) is has inconsistent reliability, no content validity testing, and no reporting of readability. The PMAS (Parent Mealtime Action Scale) has decent convergent validity (Pearson coefficient at 0.69) and good internal and test-retest reliability (Cronbach's alpha at 0.62

and test-retest reliability coefficient at 0.62), but has no reporting of content validity or readability, and has a limited target age range. The STEP-CHILD (Screening Tool of Feeding Problems applied to children) has good convergent validity (mean convergent validity coefficient at 0.69), but no reporting on reliability, content validity, or readability. Instead, the Pedi-EAT assessment should be utilized due to its wide range of age for intended use as well due to its content validity testing, low readability levels, and wide age range.

E.3. Intake Trackers

While initially the desire was to limit applications to those that are free to use, the application *Baby Connect* was reviewed due to its use in a peer-reviewed article. This application can only be used after a one-time purchase of $4.99 USD. Since it has been used in a peer-reviewed article and ranked highest out of the rest of the applications we reviewed, *Baby Connect* would be the mobile application recommended if price is not an issue. The application *FeedBaby*, in both its free and paid versions, was reviewed as well. In order to directly compare with the published literature on *FeedBaby*, the paid version was reviewed due to the fact that a review of the application was published in the *MHealth* journal (Chaudhry, 2016). The review highlighted the different features available, noting the ability for parents and pediatricians to monitor a baby's sleep, eating, and development. This application is also recommended due to its ranking second highest out of the mobile applications reviewed. It has a high number of desired features while also being the most aesthetically pleasing and intuitive application. The icons used

are clear and the user interface is easy to understand. In its paid form however, it does not come with as many features as *Baby Connect*. *Baby Connect* would be recommended over *FeedBaby* in its paid form, especially since *Baby Connect* is cheaper.

Out of all the applications reviewed where no purchase was necessary, the application *BabyNursing* had the most features. While it does have a premium version for sale, the free version has many available features that make it worth using when cost is considered. In its unpaid form, it has more features available than *FeedBaby*'s unpaid form as shown in Table 15. The limitations of *BabyNursing* are that a timer function is not available for bottle and solid feeding; because of these limitations, *BabyConnect* and *FeedBaby* (in its paid form), are both recommended for use over *BabyNursing*.

For calorie trackers, the application *MyFitnessPal* is recommended, as it has the most desired features while having a fairly easy to use and intuitive interface with understandable icons and progress reports. The partnership of *MyFitnessPal* with the major active wear brand *Under Armour* shows that it is an established application with continued backing and support. *Fooducate* also has the same amount of desired features, but the user interface is not as easy to navigate as *MyFitnessPal*. While *Cronometer* is currently in use at the BCH GNP by certain dieticians, it does not have as many desired features as other mobile applications. All three applications only allow for data export through a premium (paid) membership. With regards to unpaid versions, *MyFitnessPal* is the recommended choice.

Future directions for clinical use of the recommended intake trackers would include contacting the companies that published the applications and possibly collaborating/partnering.

Literature Review of Mobile Application Use for Feeding Tracking

The literature search only yielded 1 result of a mobile application being used for tracking of feedings in infants, as shown above in Table 16. The second entry, marked with an asterisk (*), a review of the application '*Feed Baby*,' was found only after consultation with a BCH librarian in which a much more thorough literature search was performed (Search terms provided in APPENDIX A). Even with professional assistance, there was not any other literature available that we could find with similar goals as the BCH GNP, suggesting a lack of research in this area. A literature search of mobile application use in tracking feedings for children yielded 3 more results, as shown in Table 17. However, the applications were not focused on patient use for tracking intake with data export to clinicians, major objectives for the BCH GNP. More research still needs to be done on mobile application use in tracking of feedings for direct application to the BCH GNP.

E.4. Conclusions

The current study described the demographic, social, and clinical characteristics of patents seeking care at the Boston Children's Hospital Growth and Nutrition Program. The literature review revealed three feeding assessments (NeoEAT, Pedi-EAT, and

ChOMPS) recommended for use over the BPFAS currently in use at the clinic. The

mobile applications *Baby Connect* and *FeedBaby* are recommended for tracking of infant

feeding, while *MyFitnessPal* is recommended for calorie tracking over the application

Cronometer currently in use at the clinic.

APPENDICES

APPENDIX A:

Librarian Search Terms:

Search (((malnutrition) AND (mobile[tiab] OR digital[tiab])) AND ("last 10 years"[PDat]

AND English[lang] AND (infant[MeSH] OR child[MeSH] OR adolescent[MeSH])))

Filters: published in the last 10 years; English; Child: birth-18 years

Search ((((calorie[tiab] OR food[tiab]) AND (mobile[tiab] OR digital[tiab])) AND ("last

10 years"[PDat] AND English[lang] AND (infant[MeSH] OR child[MeSH] OR

adolescent[MeSH])))) NOT ((calorie[tiab] AND (mobile[tiab] OR digital[tiab])) AND

("last 10 years"[PDat] AND English[lang] AND (infant[MeSH] OR child[MeSH] OR

adolescent[MeSH]))) Filters: published in the last 10 years; English; Child: birth-18 years

Search (calorie[tiab] OR food[tiab]) AND (mobile[tiab] OR digital[tiab]) Filters:

published in the last 10 years; English; Child: birth-18 years

Search calorie[tiab] AND (mobile[tiab] OR digital[tiab]) Filters: published in the last 10

years; English; Child: birth-18 years

Search calorie tracking AND (mobile[tiab] OR digital[tiab]) Filters: published in the last

10 years; English; Child: birth-18 years

Search ("Mobile Applications/utilization"[MeSH]) Filters: published in the last 10 years;

English; Child: birth-18 years

Search ("Mobile Applications/utilization"[MeSH]) AND ("Energy Intake"[MeSH] OR

calories OR food) Filters: published in the last 10 years; English; Child: birth-18 years

Search ("Mobile Applications/utilization"[MAJR]) AND ("Energy Intake"[MeSH] OR calories OR food) Filters: published in the last 10 years; English; Child: birth-18 years

Search ("Mobile Applications/utilization"[MAJR]) AND ("Energy Intake"[MAJR] OR calories OR food) Filters: published in the last 10 years; English; Child: birth-18 years

Search ((calorie tracker[tiab] OR food tracker[tiab] OR calorie journal OR calorie tracking OR food diary OR food logging[tiab])) AND (mobile apps OR digital[tiab] OR personal device*[tiab] OR computer OR laptop OR technology[tiab] OR smart device[tiab] OR tablet OR PDA OR handheld computer OR electronic[tiab] OR smartphone) Filters: published in the last 10 years; English; Child: birth-18 years

Search ((calorie tracker[tiab] OR food tracker[tiab] OR calorie journal OR calorie tracking OR food diary OR food logging[tiab])) AND (mobile apps OR digital[tiab] OR personal device*[tiab] OR computer OR laptop OR technology[tiab] OR smart device[tiab] OR tablet OR PDA OR handheld computer OR electronic[tiab] OR smartphone) Filters: English; Child: birth-18 years

Search ((calorie tracker[tiab] OR food tracker[tiab] OR calorie journal OR calorie tracking OR food diary OR food logging[tiab])) AND (mobile apps OR digital[tiab] OR personal device*[tiab] OR computer OR laptop OR technology[tiab] OR smart device[tiab] OR tablet OR PDA OR handheld computer OR electronic[tiab] OR smartphone) Filters: Child: birth-18 years

Search ((calorie tracker[tiab] OR food tracker[tiab] OR calorie journal OR calorie tracking OR food diary OR food logging[tiab])) AND (mobile apps OR digital[tiab] OR personal device*[tiab] OR computer OR laptop OR technology[tiab] OR smart

device[tiab] OR tablet OR PDA OR handheld computer OR electronic[tiab] OR smartphone)

Search ((calorie tracker OR calorie journal OR calorie tracking OR food diary OR food logging[tiab])) AND (mobile apps OR digital[tiab] OR personal device*[tiab] OR computer OR laptop OR technology[tiab] OR smart device[tiab] OR tablet OR PDA OR handheld computer OR electronic[tiab] OR smartphone)

Search ((((calorie tracker[tiab] OR food tracker[tiab] OR calorie journal OR calorie tracking OR food diary OR food logging[tiab])) AND malnutrition))) AND (mobile apps OR digital[tiab] OR personal device*[tiab] OR computer OR laptop OR technology[tiab] OR smart device[tiab] OR tablet OR PDA OR handheld computer OR electronic[tiab] OR smartphone)

Search ((((calorie tracker[tiab] OR food tracker[tiab] OR calorie journal OR calorie tracking OR food diary OR food logging[tiab])) AND malnutrition) AND ((infant[MeSH] OR child[MeSH] OR adolescent[MeSH])))) AND (mobile apps OR digital[tiab] OR personal device*[tiab] OR computer OR laptop OR technology[tiab] OR smart device[tiab] OR tablet OR PDA OR handheld computer OR electronic[tiab] OR smartphone)

Search ((((calorie tracker[tiab] OR food tracker[tiab] OR calorie journal OR calorie tracking OR food diary OR food logging[tiab])) AND malnutrition) AND ((infant[MeSH] OR child[MeSH] OR adolescent[MeSH])))) AND (mobile apps OR digital[tiab] OR personal device*[tiab] OR computer OR laptop OR technology[tiab] OR

smart device[tiab] OR tablet OR PDA OR handheld computer OR electronic[tiab] OR

smartphone) Filters: Child: birth-18 years

Search ((calorie tracker[tiab] OR food tracker[tiab] OR calorie journal OR calorie

tracking OR food diary OR food logging[tiab])) AND malnutrition Filters: Child: birth-

18 years

Search ((calorie tracker[tiab] OR food tracker[tiab] OR calorie journal OR calorie

tracking OR food diary OR food logging[tiab])) AND malnutrition

Search calorie tracker[tiab] OR food tracker[tiab] OR calorie journal OR calorie tracking

OR food diary OR food logging[tiab]

Search calorie tracker OR calorie journal OR calorie tracking OR food diary OR food

logging[tiab]

Search calorie trac*

Search calorie track*

Search calorie tracking

Search malnutrition

Search 27784506[uid]

Search The effectiveness of mobile-health technology-based health behaviour change or

disease management interventions for health care consumers: a systematic review.

Search New[Title] AND app[Title] AND streamline[Title] AND breast[Title] AND

milk[Title] AND management[Title] AND NICU[Title]

Search . New app may streamline breast milk management in the NICU Filters: English

Search (((((((breastfeeding OR breastmilk OR infant formula OR breast milk[tiab] OR milk[tiab] OR infant food[tiab] OR baby food*[tiab])))) AND English[lang])) AND (tracking[tiab] OR logging[tiab] OR diary OR diet records[MeSH] OR food diary)) AND (mobile apps OR digital[tiab] OR personal device*[tiab] OR computer OR laptop OR technology[tiab] OR smart device[tiab] OR tablet OR PDA OR handheld computer OR electronic[tiab] OR smartphone) Filters: English

Search (((((((breastfeeding OR breastmilk OR infant formula OR breast milk[tiab] OR milk[tiab] OR infant food[tiab] OR baby food*[tiab])))) AND English[lang])) AND (tracking[tiab] OR logging[tiab] OR diary OR diet records[MeSH] OR food diary)) AND (mobile apps OR digital[tiab] OR personal device*[tiab] OR computer OR laptop OR technology[tiab] OR smart device[tiab] OR tablet OR PDA OR handheld computer OR electronic[tiab] OR smartphone)

Search (((((((breastfeeding OR breastmilk OR infant formula OR breast milk[tiab] OR milk[tiab] OR infant food[tiab] OR baby food*[tiab])))) AND English[lang])) AND (tracking[tiab] OR logging[tiab] OR diary OR journal[tiab] OR diet records[MeSH] OR food diary)) AND (mobile apps OR digital[tiab] OR personal device*[tiab] OR computer OR laptop OR technology[tiab] OR smart device[tiab] OR tablet OR PDA OR handheld computer OR electronic[tiab] OR smartphone) Filters: English

Search (((breastfeeding OR breastmilk OR infant formula OR breast milk[tiab] OR milk[tiab] OR infant food[tiab] OR baby food*[tiab]))) Filters: English

Search ((((breastfeeding OR breastmilk OR infant formula[tiab] OR breast milk[tiab] OR thickened feed*[tiab] OR milk[tiab] OR infant food[tiab] OR baby food*[tiab] OR

feeds[tiab] OR feeding[tiab])))) AND (mobile apps OR digital[tiab] OR personal device*[tiab] OR computer OR laptop OR technology[tiab] OR smart device[tiab] OR tablet[tiab] OR handheld computer OR electronic[tiab] OR smartphone)) AND (tracking[tiab] OR logging[tiab] OR diary OR journal[tiab] OR diet records[MeSH] OR food diary) Filters: English

Search (((((breastfeeding OR breastmilk OR infant formula[tiab] OR breast milk[tiab] OR thickened feed*[tiab] OR milk[tiab] OR infant food[tiab] OR baby food*[tiab] OR feeds[tiab] OR feeding[tiab]) AND (English[lang] AND (infant[MeSH:noexp] OR infant[MeSH] OR infant, newborn[MeSH])))) AND (mobile apps OR digital[tiab] OR personal device*[tiab] OR computer OR laptop OR technology[tiab] OR smart device[tiab] OR tablet[tiab] OR handheld computer OR electronic[tiab] OR smartphone)) AND (tracking[tiab] OR logging[tiab] OR diary OR journal[tiab] OR diet records[MeSH] OR food diary) Filters: English

Search (((((breastfeeding OR breastmilk OR infant formula[tiab] OR breast milk[tiab] OR thickened feed*[tiab] OR milk[tiab] OR infant food[tiab] OR baby food*[tiab] OR feeds[tiab] OR feeding[tiab]) AND (English[lang] AND (infant[MeSH:noexp] OR infant[MeSH] OR infant, newborn[MeSH])))) AND (mobile apps OR digital[tiab] OR personal device*[tiab] OR computer OR laptop OR technology[tiab] OR smart device[tiab] OR tablet[tiab] OR handheld computer OR electronic[tiab] OR smartphone)) AND (tracking[tiab] OR logging[tiab] OR diary OR journal[tiab] OR diet records[MeSH] OR food diary) Filters: English; Infant: 1-23 months; Infant: birth-23 months; Newborn: birth-1 month

Search breastfeeding OR breastmilk OR infant formula[tiab] OR breast milk[tiab] OR thickened feed*[tiab] OR milk[tiab] OR infant food[tiab] OR baby food*[tiab] OR feeds[tiab] OR feeding[tiab] Filters: English; Infant: 1-23 months; Infant: birth-23 months; Newborn: birth-1 month

Search (breastfeeding OR breastmilk OR infant formula OR breast milk[tiab] OR thickened feed*[tiab] OR milk[tiab] OR infant food[tiab] OR baby food*[tiab] OR feeds[tiab] OR feeding[tiab]) Filters: English; Infant: 1-23 months; Infant: birth-23 months; Newborn: birth-1 month

Search (((tracking[tiab] OR logging[tiab] OR diary OR journal[tiab] OR diet records[MeSH] OR food diary)) AND (breastfeeding OR breastmilk OR formula OR infant formula OR breast milk OR thickened feed*[tiab] OR milk[tiab] OR infant food OR baby food OR feeds[tiab] OR feeding[tiab])) AND (mobile apps OR digital[tiab] OR personal device*[tiab] OR computer OR laptop OR technology[tiab] OR smart device[tiab] OR tablet OR PDA OR handheld computer OR electronic[tiab] OR smartphone) Filters: English; Infant: 1-23 months; Infant: birth-23 months; Newborn: birth-1 month

Search (((tracking[tiab] OR logging[tiab] OR diary OR journal[tiab] OR diet records[MeSH] OR food diary)) AND (breastfeeding OR breastmilk OR formula OR infant formula OR breast milk OR thickened feed*[tiab] OR milk[tiab] OR infant food OR baby food OR feeds[tiab] OR feeding[tiab])) AND (mobile apps OR digital[tiab] OR personal device*[tiab] OR computer OR laptop OR technology[tiab] OR smart

device[tiab] OR tablet OR PDA OR handheld computer OR electronic[tiab] OR

smartphone) Filters: English; Infant: 1-23 months; Infant: birth-23 months

Search (((tracking[tiab] OR logging[tiab] OR diary OR journal[tiab] OR diet

records[MeSH] OR food diary)) AND (breastfeeding OR breastmilk OR formula OR

infant formula OR breast milk OR thickened feed*[tiab] OR milk[tiab] OR infant food

OR baby food OR feeds[tiab] OR feeding[tiab])) AND (mobile apps OR digital[tiab] OR

personal device*[tiab] OR computer OR laptop OR technology[tiab] OR smart

device[tiab] OR tablet OR PDA OR handheld computer OR electronic[tiab] OR

smartphone) Filters: English

Search (((tracking[tiab] OR logging[tiab] OR diary OR journal[tiab] OR diet

records[MeSH] OR food diary)) AND (breastfeeding OR breastmilk OR formula OR

infant formula OR breast milk OR thickened feed*[tiab] OR milk[tiab] OR infant food

OR baby food OR feeds[tiab] OR feeding[tiab])) AND (mobile apps OR digital[tiab] OR

personal device*[tiab] OR computer OR laptop OR technology[tiab] OR smart

device[tiab] OR tablet OR PDA OR handheld computer OR electronic[tiab] OR

smartphone)

Search tracking[tiab] OR logging[tiab] OR diary OR journal[tiab] OR diet

records[MeSH] OR food diary

Search breastfeeding OR breastmilk OR formula OR infant formula OR breast milk OR

thickened feed*[tiab] OR milk[tiab] OR infant food OR baby food OR feeds[tiab] OR

feeding[tiab]

Search mobile apps OR digital[tiab] OR personal device*[tiab] OR computer OR laptop

OR technology[tiab] OR smart device[tiab] OR tablet OR PDA OR handheld computer

OR electronic[tiab] OR smartphone

Search digital

Search mobile apps

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