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Maternal Determinants of the Timing of Introduction of Complementary Food to Infants

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This thesis, THE MATERNAL DETERMINANTS OF THE TIMING OF INTRODUCTION OF COMPLEMENTARY FOOD TO INFANTS, by Susana N. Morphis was prepared under the direction of the Master's Thesis Advisory Committee. It is accepted by the committee members in partial fulfillment of the requirements for the degree Master of Science in the Byrdine F. Lewis College of Nursing and Health Professions, Georgia State University. The Master's Thesis Advisory Committee, as representatives of the faculty, certify that this thesis has met all standards of excellence and scholarship as determined by the faculty.

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ABSTRACT

THE MATERNAL DETERMINANTS OF THE TIMING OF INTRODUCTION OF COMPLEMENTARY FOOD TO INFANTS

By Susana N. Morphis

Background: Recommendations from most United States professional and public health organizations in indicate that infants should begin eating complementary foods (CF) at 6 months of age. Despite this recommendation, parents frequently introduce CF to their infants earlier. To our knowledge, no previous studies have assessed maternal awareness of feeding guidelines, and whether this knowledge influences decision making around infant feeding. We hypothesized that the majority of mothers introduce CF before the recommended age or appropriate developmental milestones due to limited awareness of current feeding guidelines.

Methods: This observational cross-sectional study surveyed the maternal factors that influenced the timing of introduction of CF in infants in a sample of mothers who sought counseling at the Atlanta-based non-profit, Peapod Nutrition and Lactation Support.

Results: Fourteen mothers completed the survey on feeding practices, and over half of the mothers indicated that they waited until 6 months to introduce CF to their infants. All of the mothers knew the correct age recommendation for the introduction of CF. Some of the mothers indicated that they used professional organization recommendations to decide when to feed their infants, but some of the other reasons included influence from a pediatrician, developmental readiness, and the desire for their infant to sleep longer or go longer between breastfeeding sessions. Because all mothers were aware of the guidelines, we failed to reject the null

hypothesis that there is no association between early introduction of CF and limited knowledge of the recommendations.

Conclusion: This study found that mothers choose to introduce CF for various reasons beyond public health guidelines. Future studies investigating similar questions would benefit from a larger sample size and a longer duration.

MATERNAL DETERMINANTS OF THE TIMING OF INTRODUCTION OF COMPLEMENTARY FOOD TO INFANTS

by

Susana N. Morphis

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ABBREVIATIONS

CF	Complementary Food
AAP	American Academy of Pediatrics
Peapod	Peapod Nutrition and Lactation Support
RD	Registered Dietitian
IBCLC	International Board-Certified Lactation Consultant
WHO	World Health Organization
Academy	Academy of Nutrition and Dietetics
ESPGHAN	European Society for Paediatric Gastroenterology, Hepatology, and Nutrition
CDC	Centers for Disease Control and Prevention
NIAID	National Institute of Allergy and Infectious Diseases
IU	International Units
mg	milligram
kg	kilogram
IFPS II	Infant Feeding Practices Study II
FITS	Feeding Infants and Toddler Study
NHANES	National Health and Nutrition Examination Survey
TRIGR	Trial to Reduce IDDM in Genetically at Risk
RDA	Recommended Dietary Allowance
EAR	Estimated Average Requirement
DRI	Dietary Reference Intake

µg	microgram
WIC	Supplemental Nutrition Program for Women, Infants, and Children
DoH	UK Department of Health
UK	United Kingdom

CHAPTER I

MATERNAL DETERMINANTS OF THE TIMING OF INTRODUCTION OF COMPLEMENTARY FOOD TO INFANTS

Introduction

Previous research has established that infancy is a critical time for establishing healthy eating habits, preventing allergies, and preventing obesity and its comorbidities.[1,2] The current guidelines reflect an array of evidence indicating that exclusive breastfeeding for the first 6 months of life can optimally nourish the rapid growth and development of infants while providing immune protection.[3] Delaying the introduction of complementary food (CF) until 6 months of age while exclusively breastfeeding may decrease an infant's risk of pneumonia and other respiratory disorders, gastrointestinal disorders, otitis media, sudden infant death syndrome, diabetes, eczema, and unhealthy weight status.[3-5] Given that nutrition in infancy is critical, the American Academy of Pediatrics (AAP) asserts in their policy statement that "infant nutrition should be considered a public health issue and not only a lifestyle choice."[4] Despite the impact infant nutrition can have on health throughout the lifespan, adherence to infant feeding guidelines is poor.[6,7]

Both the recommended age of introduction of CF and the types of CF introduced to infants have low levels of compliance. Prior research has attempted to measure the level of guideline adherence for both of these factors.[7-10] The results vary widely due different study populations, regional guidelines, and definitions of CF. For the purpose of this study, CF will refer to both solid and liquid forms of energy that are not human milk or infant formula. Despite

a wide variety of results, the actual timing of infants' introduction to CF is disparate from guidelines.[7-10] Types of food introduced also stray from recommendations, with many infants exposed to foods that should be avoided such as foods high in fat, sugar, and sodium.[11]

Other studies have sought to establish predictors of adherence.[12,13] This research has indicated several demographic and personal characteristics such as maternal age, race, parity, and responsiveness.[5,12,14] Almost all studies concluded that the type of milk fed significantly impacted the age of introduction of CF, with breastfeeding being a predictor of delayed CF introduction.[8,12,15] Although there is some descriptive information about the typical characteristics of individuals who follow or do not follow professional feeding guidelines, the reasons why people choose to begin introducing CF are unknown. Because of the paucity of research on what influences the timing of CF introduction, this study aims to determine why parents choose to begin feeding CF. Further details of what drives parents to make feeding decisions will help to inform future health promotion and intervention.

This study will investigate the maternal determinants for introducing CF to infants at Peapod Nutrition and Lactation Support (Peapod), a non-profit organization providing nutrition and lactation consultations by registered dietitians (RD) and international board-certified lactation consultants (IBCLC) with locations in Atlanta and Decatur, GA. Peapod provides services to families with diverse socioeconomic statuses as well as racial, ethnic, and educational backgrounds. The population will include women who visited when their infant was less than one year of age and completed a follow-up survey regarding the use and knowledge of CF. We hypothesize that the majority of mothers introduced CF before the recommended age or appropriate developmental milestones and that there is an association between this practice and

awareness of current feeding guidelines. The null hypothesis is that there is no association between the initiation of CF and knowledge of feeding guidelines.

CHAPTER II

Review of the Literature

Recommendations for the Timing of CF

Despite the wide variety of ages that infants are introduced to CF and some discrepancy amongst professionals, recommendations are relatively consistent. The World Health Organization (WHO) recommends that infants should be offered CF in addition to breastmilk at 6 months of age. Between the ages of 6 to 8 months, the WHO suggests infants receive CF 2 to 3 times per day.[16] The AAP also recommends that infants breastfeed exclusively until about 6 months before adding CF to their diets.[17] The Academy of Nutrition and Dietetics (the Academy) reaffirms the recommendations of the WHO and AAP and also encourages exclusive breastfeeding until 6 months of age, followed by the addition of CF.[18] One discrepancy in recommendations comes from the guidelines of the European Society for Paediatric Gastroenterology, Hepatology, and Nutrition (ESPGHAN), which recommends that CF should be started as early as 4 months and as late as 6 months. The society claims that the WHO's recommendation is predominantly based on research regarding exclusively breast-fed infants, and may not be the best guideline when formula-fed infants are considered.[19]

A study conducted by the Centers for Disease Control and Prevention (CDC) attempted to discern whether or not childhood obesity prevalence is influenced by the introduction of CF between 4 to 6 months versus after 6 months and whether this association would be affected by breastfeeding duration.[7] One of the proposed mechanisms for the association between early introduction of CF and the development of obesity is its ability to alter the composition of gut flora the infant microbiome.[20] Introduction to solid food before 3 months may be associated with

strains of gut bacteria that have also been associated with obesity and hypertension. It is plausible that early introduction to CF can have long lasting effects on the microbiome, predisposing those infants to obesity in their lifespan. Despite this possibility, the CDC's study found no significant differences in obesity between children who started CF at 4 to 6 months and those who began at ≥6 months. They also did not find any significant variation of these results when breastfeeding duration was taken into account. Despite the study's null findings, they reaffirmed the CDC's recommendation that infants be exclusively breastfed for 6 months before introducing complementary foods.

The CDC also recommends parents utilize developmental signs that their child may be ready to start CF. These signs include sitting without or with minimal support, adequate head control, and displaying interest in food by opening his or her mouth when food is offered.[21,7] Following developmental cues may help families apply guidelines intended for a general audience to meet the individual and unique needs of their own healthy infants. In the United States, the one exception to the recommendation to delay introduction of foods pertains to infants with severe eczema or egg allergies, as those infants are at a greater risk for developing a peanut allergy.[22] Because of their increased risk, the National Institute of Allergy and Infectious Diseases (NIAID) recommends introducing peanut-containing foods as early 4-6 months to reduce these infants' risks for peanut allergies. Children with moderate or no eczema or allergies should still delay introduction to peanut-containing foods until 6 months.

Recommendation for the Composition of CF

Although there is no concrete order that healthy infants are advised to integrate food groups into their diets, experts suggest several optimal foods to start and foods to avoid.[6,22]

Because breastmilk is not a significant source of iron or zinc, exclusively breast-fed infants should eat foods rich in these nutrients to meet requirements when body stores are depleted (4 to 6 months of age). Good sources of iron and zinc for infants can include meats, poultry, fish, tofu, beans, lentils and fortified cereals mixed with formula or breastmilk. [22,23] The CDC recommends that infants consume fortified cereals made from oats, barley, or multi-grain instead of pure rice to avoid arsenic exposure.[21] Experts also dissuade parents from adding these cereals or any other foods to bottles to prevent aspiration.[17,22]

In addition to iron-rich foods, infants should enjoy a variety of foods including vegetables, fruits, whole grains, meats, poultry, and fish.[22] It is helpful to introduce these foods one at a time to simplify allergy identification. It is not necessary to delay the introduction of potential allergens past 6 months. After introducing a new food, parents should wait 3-5 days before introducing another food. Foods can be combined after each component has been introduced individually.[21]

Some forms of supplementation may also be recommended, particularly in exclusively breastfed infants. Breastfed infants should typically supplement with over-the-counter vitamin D drops containing about 400 IU under their pediatricians' supervision.[24,25,26] Some infants may also be advised to supplement with 1 mg/kg per day with iron drops due to low levels in breast milk.[23] Most formula-fed infants do not require vitamin D and iron supplementation, but decisions should be made on an individual basis with the help of health professionals.[23,25,26]

CF should be safe and age appropriate. Textures should be soft and not sticky to prevent choking. Infants at 6 months can begin eating very soft foods and progressively increase texture as they age.[22] Experts also recommend avoiding honey, cow's milk and unpasteurized foods and beverages. Honey should be avoided to prevent life-threatening illness from botulism, and

unpasteurized products can introduce the bacteria *E. coli*. Cow's milk should not replace infant formula or breastmilk as it does not contain the appropriate nutrients and has excessive proteins for the infant's age. All of these foods should be avoided before 12 months of age.[24] Other CF that should be avoided include food with added sugars and salt. Sugar-sweetened beverages, desserts, and any other sweetened items should be avoided in the first 2 year of life. No juices, even 100% fruit juices, are recommended despite their wide consumption.[17] Foods high in sodium should also be avoided. Infant foods do not need to be seasoned with table salt, and processed snacks and meats should be limited.[24]

Adherence to Age Recommendations for Introducing CFs

The point in time, location, personal characteristics of participants, and study methods can influence the timing and composition of complementary feeding per various study outcomes. Because of these study differences, reported ages of first CF introduction varies greatly; however, all studies show disparities between recommendations and actual behavior. Exclusive breastfeeding until the introduction of complementary food at 6 months is the ideal standard for infant feeding, but studies report actual adherence to this recommendation to be low. A longitudinal study by Fegan et al. (2016) found that a mere 6.8% of infants in a Canadian sample were exclusively breastfed until 6 months.[3] Similarly, an international study of infants at genetic risk for type 1 diabetes by Nucci et al. (2017) found that less than 4% of infants were still being exclusively breastfed at 6 months of age.[27] Data derived from the Infant Feeding Practices Study II (IFPS II) conducted by the CDC shows that 90% of study participants started solids before 6 months of age.[7] Compared to this data from the United States, adherence to Canadian guidelines

as reported by Fegan et al. (2016) in the KFL&A Infant Feeding Survey, is slightly better as 76% of sampled Canadian mothers introduced solids prior to 6 months.[3]

Although these studies found only a small percentage of American parents following these guidelines, many infants were introduced to CF between 4-6 months, an age still supported by some organizations.[19] 47% of infants in the IFPS II study 47% of infants began CF between 4-6 months, and the Feeding Infants and Toddler Study (FITS) 2008 found that the majority of their participants initiated CF between 4 and 5.9 months.[7,11] Consistent with these studies, the National Health and Nutrition Examination Survey (NHANES) 2003-2012 found the average age of starting solids was 5.5 months,[9] and 2009-2014 NHANES data found that 38.3% of infants were introduced to CF during this period.[28]

Although the literature has not supported introducing CF before 4 months of age since before the 1990s, this practice is still relatively common.[28] A study analyzing data from the participants of the IFPS II study found that 40% of infants were introduced to solids before 4 months old.[8] Though still alarming, several studies found more conservative results. Barrera et al. found that 16.3% of its participants were introduced to CF before 4 months[28], and Nucci et al. reported that 10% of its participants introduced CF at that time.[27]

The differences in results amongst these studies can likely be attributed to differences in timing, methodologies and populations. For instance, the study by Clayton et al. utilized data from 1,334 mothers who participated in the IFPS II from 2005-2007,[8] whereas the study by Barrera et al. utilized data from NHANES conducted from 2009-2014.[28] Individuals who participated in IFPS II were more likely to be of a higher socioeconomic status, to be white, to be able to read English, and to have a stable mailing address than the those participating in NHANES.[8,28] In contrast to both the IFPS II and NHANES, the data used by Nucci et al. (2017)

was from the Trial to Reduce IDDM in Genetically at Risk (TRIGR). The TRIGR study cohort spans 12 different countries and only includes infants who are genetically at risk for type 1 diabetes mellitus.[27] Because of these differences, the TRIGR study results may represent a more international perspective while the NHANES data may be the most nationally representative in the United States. Regardless of the variance across studies, it is still clear that adherence to recommendations regarding the timing of CF is low.

Adherence to Food Type Recommendations for Introducing CF

In addition to poor adherence to recommendations for the timing of CF, adherence to recommendations for the type of first foods that should be offered is also limited. Because guidelines emphasize that infants' first foods should be rich in iron, it may be encouraging that most North American children, 54%, received cereal as their first foods.[27] Although it would be ideal for introduction of these first foods to be delayed until 6 months, data from FITS 2008 reports that 50.4% of 4-5.9 month old infants consumed infant cereal, followed by 79.1% at 6-8.9 months.[11] Although half of infants were reportedly introduced to their first foods before recommended, they were in compliance with guidelines that first foods should be rich in iron. Introduction to other iron containing foods generally occurred later than infant cereals. The FITS 2008 found that 3.1%, 38.5%, and 76.9% of infants consumed any complementary meat or protein source at 4-5.9, 6-8.9, and 9-11.9 months respectively.[11] Data from the NHANES reports that mean iron consumption for children 0-24 months between 2003-2012 was 10.2 mg per day.[9] This intake falls slightly below the 11 mg recommended dietary allowance (RDA) for 7-12 month-olds but well over the 7mg RDA for 1-3 year-olds.[29] The FITS 2008 reported that the mean iron intake for infants 6-11 months was 15.8 mg per day, indicating that most infants met iron recommendations.[10] Unfortunately, about 12% of the sample comprised an at-risk

population who consumed inadequate amounts of iron compared to the estimated average requirement (EAR).

In addition to cereals, fruits and vegetables tended to be popular first foods. Although these are nutritious first foods, many infants were offered them earlier than recommended. Nucci et al. reported that by 6 months of age, 48% of infants sampled were consuming cereals, fruits and vegetables.[27] Between 4 and 5.9 months, 18.5% of infants had consumed fruit and 25.9% had consumed vegetables; by 9 and 11.9 months, 80.6% of infants had consumed fruit and 72.3% had consumed vegetables.[11] Although these percentages reflect the majority, they indicate that there is still a large number of infants who had not consumed any fruits or vegetables by age one.

Similarly, the majority of infants met the recommended intake for vitamin D, but a significant number of infants still fell short. The FITS 2008 found that the median intake of vitamin D amongst the 6-11-month-olds sampled was 7.4 μg per day, surpassing the dietary reference intake (DRI) of 5 μg. Despite the sufficient intake amongst most of these infants, all quartiles below the median did not meet the DRI, suggesting that some breastfed infants are not given vitamin D supplementation as advised by health professionals.[10]

As mentioned previously, experts also advise against giving cow's milk before one year. Regardless of these recommendations, the NHANES reports that children are first fed milk at an average age of 11.4 months.[9] The FITS data reinforces that of NHANES in that 5.3% of 6-8.9 month-olds and 16.6% of 9-11.9 month-olds consume cow's milk. These reports are disconcerting because there is a general consensus that cow's milk should not replace infant formula or breastmilk before one year.[30]

Experts also agree that CF should not include foods high in sugars and salt. Despite this recommendation, FITS 2008 reports that 4.8%, 17%, and 43% of infants ages 4-5.9, 6-8.9, and 9-11.9 months respectively consumed any type of dessert, sweet or sweetened beverage.[11] All of these percentages are cause for concern, but it is particularly concerning that close to 5% of infants not yet at the recommended age to consume any CFs are consuming foods with added sugars. Although not technically added sugars, FITS 2008 also reported that infants are obtaining excess calories and sugars in place of breastmilk or formula through 100% fruit juices, as 7.1%, 31.2%, and 40.9% of infants are consuming 100% fruit juices at ages 4-5.9, 6-8.9, and 9-11.9 respectively.[11] These intake levels contrast with the consensus of key national health and nutrition organizations that fruit juice should not be consumed until at least one year of age at which recommendations allow for the consumption of up to 4 ounces per day.[30]

Finally reports of sodium intake differs amongst datasets, likely due to age differences in samples. FITS 2008 found that the median sodium intake amongst infants 6 to 11 months was 365 mg, just below the 370 mg DRI.[10] Intakes increased in 6 to 11 month-olds to 650 mg and 1,104 mg in the 75th and 90th percentiles. The FITS mean intake of 528 mg is in sharp contrast to the mean NHANES intake which was 1,016 mg per day amongst infants ages 0-24 months.[9,10] Similar to the adherence to recommendations for the age of initiation of CF, adherence to recommendations for types of CF is also inadequate. Understanding why parents do not follow these guidelines may elucidate potential future interventions for increasing adherence to nutrition advice.

Predictors and Reasons for Poor Adherence to CF Timing Recommendations

Several studies have explored the predictors and reasons for early introduction of CF. Many predictors, which include demographic and personal characteristics and choices associated with early introduction of CF, are well established across a variety of study settings, whereas other predictors are still inconsistent. Reasons for introduction, which explain contributing factors or potential causes for making feeding decisions, are still being explored and scarce throughout the literature.

Across the pertinent literature, the type of milk infants consume is the most agreed upon predictor for the timing of introduction of CF. Although various studies looked at different lengths of exclusive breastfeeding, the evidence is consistent that mothers who breastfed were more likely to delay complementary feeding compared to mothers who fed their infants formula or both formula and breastmilk.[3,6,8,9,12-15] Research by Clayton et al. found that of the infants introduced to CF before 4 months of age, 24.3% were breastfed compared to 52.7% who were formula fed and 50.2% mixed.[8] Similarly, a study by Doub et al. (2015) found that mothers practicing exclusive breastfeeding for 4 months initiated feeding significantly later with a mean age of 19.43 weeks.[6] This age is almost a full month later than the mean age of 15.57 weeks in infants fed formula. There was no statistically significant difference between formula-fed infants and mixed-fed infants despite their slightly higher mean age of introduction at 16.92 weeks.[6] Several other studies also explored the relationship between breastfeeding at 4 months and early CF initiation. One study found that not breast feeding for 4 months was associated with both the introduction of CF before 3 month and between 3-6 months.[14] Wang et al. (2019) corroborated these results that never breastfeeding or breastfeeding for less than 4 months is associated with

early introduction to CF and added that it is also associated with infant consumption of non-recommended foods.[15]

Studies that observed exclusive breastfeeding at 6 months of age were consistent with the previously mentioned studies observing breastfeeding until 4 months. Multiple studies supported that infants fed formula before 6 months were more likely to be introduced to CF early.[3,12] Furthermore, one study claimed that even 5 weeks of full breastfeeding doubled the likelihood for later initiation of solid foods, indicating exclusivity for 4-6 months may not be necessary to see an association.[13] Clayton et al. (2013) found that women who breastfed and women who formula fed had different types of reasons for introducing CF. Breastfeeding women cited reasons such as perceived infant hunger and poor sleep, whereas mothers who formula fed were 1.79 times more likely to indicate that a healthcare professional had encouraged them to begin solid foods.[8] Brown corroborated the results that breastfeeding mothers were more likely to initiate CF due to hunger by reporting an association between breastfeeding and "perceiving the infant was hungrier or needing more than milk could offer."[5]

Like the type of milk an infant is fed, many maternal characteristics such as age, education, income, occupation, use of daycare, parity, marital status, smoking status, weight, and feeding style have also been shown to be a predictive of CF in several studies. Lower maternal age is associated with earlier introduction of CF in many studies,[3,5,6,8,12-15] and CF was introduced earlier amongst younger mothers regardless of breastfeeding status.[3] Tromp et al. found that CF introduction between 3 to 6 months was associated with lower maternal age and Tang et al. reported that mothers less than 25 years of age were more likely to introduce solids before 6 months.[12,14] Similarly to their findings on formula feeding, Wang et al. (2019) also found that lower maternal age was associated with early introduction of CF and non-

recommended foods.[15] Furthermore, research indicates that for every year older the mother was, the odds of CF introduction after 25 weeks of age increased 5%.[13] In a survey by Brown et al. (2016) younger mothers were significantly more likely to introduce CF for reasons of "fun" and "pressure to eat" compared to older mothers who chose reasons such as "developmental readiness" or "behavior."[5] These findings may help explain how age difference can contribute to early CF introduction.

In addition to age, many studies found that lower maternal education was often a predictor of early CF introduction.[5,6,8,15] Although the majority of the countries reviewed took place in westernized countries, one multiethnic study in the Netherlands looked at the differences between cultures within the country. The researchers found that introduction of CF before 3 months and between 3 to 6 months was associated with lower maternal education, but only amongst women of western origin.[14] Similar to education, early introduction was associated with lower income and participation in WIC.[8] Furthermore, mothers with high or low income levels report different reasons for introducing CF. "Hunger" and "pressure from others" were reasons cited more frequently by mothers in non-skilled occupations, while "developmental readiness" or "following the guidelines" were reasons more likely to be cited by mothers with professional and skilled occupations.[5]

Despite the relatively clear association between education, income and timing of CF introduction, associations between daycare attendance and timing of introduction were less apparent. One study found that women who did not return to work until their infants were at least 6 months old were less like to introduce CF early than women who went back to work sooner.[12] Another study, that specifically looked at infants who attended daycare, found similar results that mothers whose children attended daycare for at least 32 hours per week were more likely to

introduce CF early.[14] Contradicting the two previous studies, Wang et al reported that parents whose infants did not attend daycare were more likely to initiate complementary feeding early and to feed their infants non-recommended foods.[15] Brown et al. found no significant associations between reasons for introducing CF amongst parents who returned to work and those who did not.[5]

Another significant predictor of CF initiation timing in several studies was parity, despite some inconsistency between studies. Both Kronborg et al. (2014) and Tang et al. (2015) found that first-time mothers were likely to introduce CF earlier than multiparous mothers.[12,13] Likewise, other research has found that primiparous mothers initiated complementary feeding earlier regardless of breastfeeding status.[3] In contrast, one study found that multiparous mothers were more likely than first-time mothers to introduce CF between 3 to 6 months of age, yet another found no association between birth order and the age of CF introduction.[6,14] Brown et al. (2016) reported that "hunger," "need for more nutrients," "wanted to eat," or "pressure from others" were reasons more commonly chosen by primiparous mothers compared to reasons chosen by multiparous mothers which included "developmental readiness" and "because of the guidelines."[5]

Studies that investigated the impact of single versus married mothers on CF seemed to have similar results to parity. Infants living in single parent households were more likely to begin eating CF sooner.[8,14] Tromp et al. (2013) reported that single mothers were more likely to introduce CF before 3 months but did not find significant results in the 3-6 months age range.[14] Additionally reasons such as "developmental readiness" were more likely than "hunger" or "weight" to be chosen as reasons for introducing CF by married or cohabitating mothers than single mothers when surveyed.[5]

Another maternal characteristic associated with early CF introductions is smoking status. Mothers who reported smoking tended to initiate complementary feeding sooner and independent of breastfeeding status, while mothers who did not smoke tended to delay introduction.[3,13] Smoking status had similar impact on complementary feeding as maternal weight. Pre-pregnancy BMI was associated with early CF initiation across several studies.[6,15] Kronborg et al. (2014) qualified their findings by reporting that higher maternal BMI was no longer a significant predictor for early introduction of CF if the infant had been exclusively breastfed for 5 weeks.[13]

One of the other traits investigated in multiple studies is maternal feeding style and its impact on age of CF initiation. Two studies described the tendency of mothers with more controlling feeding styles and its impact on timing of CF. Doubt et al. and Harrison et al. both found that higher pressure on infants to eat by their mothers was associated with earlier introduction.[6,31] Doub et al. (2015) also noted that mothers with more responsive feeding styles were more likely to delay CF. The authors also investigated whether or not infant temperament impacted maternal feeding style, but found that feeding style is predominantly regulated by mothers.[6]

Despite these findings, infant temperament or perceived temperament is an important predictor of the age that they are first introduced to CF. For instance, infants who scored higher in motor reactivity at 6 months old were typically introduced to CF earlier than infants with lower reactivity.[6] Infant "soothability" and parental perception that their child "always want[ed] to eat when he/she [saw] someone eating" were other characteristics found to be indicative of early introduction and regular consumption of non-recommended foods.[13,15] Mothers were more likely to begin complementary feeding early if they perceived their child as having unsettled

behavior.[5] Another trait that was inversely associated with early CF introduction included the mother's perception that her child was temperamental; however, further analyses showed that this trait was only significant amongst first-time mothers.[13]

Other infant characteristics that were predictors of the age of introduction included gender, gestational age at birth, birthweight, birth order, and postnatal weight gain. Kronborg et al. reported that male infants were more likely to be fed CF later than female infants.[13] This phenomenon is interesting given the perception noted by Brown et al. that male infants are hungrier and need more energy than females.[5] In contrast to findings by Kronborg et al. (2014), Doub et al., (2015) found no significant association between infant sex and age at CF initiation.[6]

Although only noted by one study, increased gestational age was linked with later introduction of CF. Birth weight and weight gain were more frequently cited as predictors of CF timing. One study found that mothers who introduced their infants to CF later had heavier infants at birth, and analysis showed that birthweight was only associated with CF timing if the mother reported ambiguity recognizing her infant's hunger cues.[13] Another study looked at postnatal weight gain and found an association between weight gain and early introduction of CF.[15] Brown et al. found that mothers with heavier infants tend to introduce solid foods because of weight more often than mothers of lighter infants.[5] In contrast, another study reported no significant association between birthweight and the timing of CF initiation.[6]

Although it is clear that many infant characteristics can contribute to the age CF is introduced, most studies investigate the maternal perception of their infants. Overall, review of maternal beliefs may be the most telling predictors and reasons for the early or timely introduction of CF. Many studies looked at a variety of different maternal beliefs. For instance, Doub et al. (2015) investigated whether mothers were aware of feeding recommendations and

how this impacted their decisions to begin CF. Not surprisingly, mothers who held the belief that "infants need solid foods before 6 months" more often fed their infants before that time.[6] Parents who introduced CF earlier also tended to believe that "fruits and vegetables can be given to [children] freely earlier than 4 months."[15] These results show how misconceptions of infant recommendations can lead to early CF introduction. Another common misconception leading to early introduction is the belief that solid foods will help infants sleep. Mothers in multiple studies cited that they introduced CF for reasons such as "it would help my baby sleep long at night" or if they perceived their infant was not sleeping enough.[5,8] In addition the perceptions that their baby seemed temperamental, hungry, or that the baby wanted the food were also associated with early CF introduction.[8,13] Mothers who did not recognize early infant cues of hunger were more likely to feed CF early.[13] Social pressures also impacted mothers' beliefs that their infants were ready for CF. Tang et al. (2013) found that mothers were more likely to delay CF introduction if they perceived that most of their friends breastfed.[12] Another study found that pressure from other people was significantly associated with introducing CF very early.[5] Perhaps the most disconcerting reason listed for initiating CF is that a doctor or healthcare professional encouraged the parents to begin feeding solid food. This reason was reported more by mothers who fed their infants formula and may indicate a knowledge gap among health professionals.[8] Other reasons for introducing CF included concern of the infant being underweight or the infant having a medical condition that could be benefited by starting solid foods.[8,31]

Finally having a family history of asthma, atopy, or an allergy to cow's milk was inversely associated with the initiation of CF between 3 to 6 months.[14] It is possible that parents avoid initiation of food during this time due to fear of reaction or more familiarity with current guidelines. Recommendations for the initiation of potential allergens to children at higher risk for

allergies have changed several times in the past few decades and recommendations vary between countries.[2] Due to the contradictory guidance, it would be reasonable for this population to be particularly vulnerable to misunderstanding or not being aware of current recommendations.

CHAPTER III

Methods

Study Design and Population

This is an observational cross-sectional study designed to determine the maternal factors that influence the timing of introduction of CF in infants. The study population includes mothers ≥18 years of age who sought nutrition or lactation counseling at Peapod Nutrition and Lactation Support (Peapod) within the past year. Peapod is a non-profit organization located in Atlanta, Georgia. Peapod provides family nutrition support as well as breastfeeding support, office based and in-home lactation consultations, and in-person and web-based breastfeeding education classes. Peapod serves a diverse population of various ages, races, ethnicities, education, and income levels. Peapod mothers of infants who were born premature (<36 weeks gestation) will be excluded.

Complimentary Feeding Survey

The survey includes questions related to the demographic characteristics of the participant and three questions related to complementary feeding practice/knowledge (Table 1). Existing and new clients will be invited to participate in the survey via email. Eligible mothers will receive an email from Alicia Simpson, Executive Director of Peapod that includes the following statement: “You are being asked to take part in a research study looking at how mothers decide when to give solid foods to their infants. Please read the attached consent form. If you wish to take part in the study after reading the consent form please click the link below to fill in the survey. The survey should take no more than 5 minutes to do and all answers will be

kept private. Thank you! Susana Morphis, Georgia State University, MS in Health Sciences concentration in Nutrition", consent form (attached to the email), and a link to the electronic survey. The electronic survey will be created in Google Forms. All responses will be anonymous. The electronic survey responses will be available only to the research team and accessed via password protected computer. The study received expedited approval from Georgia State University IRB.

Table 1. Complementary Feeding Survey

Date of first Peapod Nutrition and Lactation Support visit: _____

Please place a check mark in the box next to your answer.

Race:
[ ] Caucasian or White
[ ] African American or Black
[ ] Asian
[ ] Mixed race

What is your age (years): _____

How many infants have you been responsible for initiating complementary foods? _____

At what age did you/do you plan to introduce your infant to solid food (including purees) or beverages that are NOT breast milk or formula?
[ ] 1 month
[ ] 2 months
[ ] 3 months
[ ] 4 months
[ ] 5 months
[ ] 6 months
[ ] 7 months
[ ] 8 months
[ ] 9+ months

Why did you/will you choose to introduce food or beverages when you did/do? (check all that apply)
[ ] The pediatrician said my child was old enough
[ ] To help my baby sleep longer

[ ] My baby shows signs of developmental readiness
[ ] My baby is the recommended age
[ ] A family member told me my child was ready for food
[ ] My baby was fussy
[ ] Concerned about slow weight gain
[ ] Concerned about infant reflux
[ ] Other: _____

What is the recommended age for infants to begin eating solid food (including purees) or beverages aside from breastmilk or formula?
[ ] 1 month
[ ] 2 months
[ ] 3 months
[ ] 4 months
[ ] 5 months
[ ] 6 months
[ ] 7 months
[ ] 8 months
[ ] 9+ months

Statistical Analysis

The demographic characteristics and complementary feeding practices/knowledge of the participant population will be described using frequency statistics. Normality statistics will be conducted for the age variable to determine the appropriate descriptive measure of central tendency. The Chi-square statistic will be used to determine differences in feeding practices/knowledge by race, maternal age group (<18 years, 19-25 years, 26-35 years, >35 years), and the number of infants previously fed CF (0, 1-2, >2). Fisher's Exact Test will be used when the expected count is less than 5 in any cell. All statistical analyses will be performed using the Statistical Program for Social Sciences (SPSS) version 25.0 database (SPSS, Inc., Chicago, IL). A P-value of <0.05 will be considered statistically significant.

CHAPTER IV

Results

The survey was completed by 14 mothers with a mean age of 33.3 (±3.0). The majority (78.6%) of the mothers identified as white, two mothers (14.3%) identified as African American/ black, and one mother (7.1%) identified as mixed race. When asked how many children they had introduced CF to before, half (n=7) of the mothers indicated they had introduced CF to one infant and the remaining mothers had introduced CF to two children. The majority (57.1%) of mothers waited until 6 months to introduce their children to CF. Approximately, one-quarter (28.6%) introduced CF to their infants at 5 months and 14.3% introduced CF at 4 months. The reasons mothers chose to introduce their infants to CF are shown in Table 1. Other reasons noted by mothers included "both my kids had issues with reflux and the food seemed to help weigh down the milk so they had much less spit ups," "early exposure to allergens to reduce food allergies," "I waited until recommended time, and "I wanted my child to be able to go longer between breastfeeds without having to give her formula." All 14 of the mothers selected six months as the recommended age to introduce CF.

Although there were no statistically significant differences (p=0.287) between mothers who introduced their infants to CF at 4, 5 and 6 months, there were some notable differences. Both mothers who introduced CF at 4 months were feeding their first child, half of the mothers who introduced CF at 5 months were feeding their first child, and the majority of mothers, 62.5%, who delayed CF until 6 months were feeding their second child. Furthermore, 66.7% of mothers who introduced CF before the recommended time were feeding their first child, whereas 62.5% of mothers who wait until the recommended time were introducing solids for the second

time. Half of mothers who fed their infants before 6 months identified as African American/black or mixed race, and 60.0% were under 35 years of age. The majority (72.7%) of the parents who delayed CF until 6 months were Caucasian and half were over 35 years of age.

Table 1. Reasons reported for introducing complimentary food or beverages to infants

Reasons	**Yes n (%)**	**No n (%)**
The pediatrician said my child was old enough	7 (50.0)	7 (50.0)
To help my baby sleep longer	2 (14.3)	12 (85.7)
My baby shows signs of developmental readiness	12 (85.7)	2 (14.3)
My baby is the recommended age	6 (42.9)	8 (57.1)
A family member told me my child was ready for food	0 (0.0)	14 (100.0)
My baby was fussy	1 (7.1)	13 (92.9)
Concerned about slow weight gain	2 (14.3)	12 (85.7)
Concerned about infant reflux	1 (7.1)	13 (92.9)

CHAPTER V

Discussion

Although the delayed introduction of CF until 6 months is recommended by major health associations such as the WHO, AAP, the Academy, and CDC in order to maximize breastfeeding and prevent or decrease chronic and acute diseases, adherence to these guidelines has been reported to be poor.[3-5,16-18] Although we hypothesized that most mothers would report introducing CF before the recommended age due to low awareness of the current guidelines, 100.0% of the mothers in our sample knew the correct guideline for age of CF introduction. Despite the mothers' accurate knowledge of the guidelines, only about half the mothers delayed CF until 6 months of age. Therefore, we failed to reject the null hypothesis that there is no association between the initiation of CF and knowledge of feeding guidelines.

Although no other studies have looked at the maternal knowledge of CF guidelines, our results were similar to previous studies in several ways. Our results corroborate the findings from several other studies that increased maternal age is associated with later introduction to CF.[5,14,15] Maternal age in this study spanned from 28 years to 38 years. We found that all of the mothers who introduced CF before 6 months were in our younger age category (26-35 years). This observation is consistent with the study results by Brown et al. where mothers who were older were more likely to feed their infants later and for reasons such as developmental readiness and following the guidelines.[5] Our findings support those of Brown et al. (2016) particularly well because the mothers in our study were generally older and more likely to introduce CF for developmental readiness compared to younger mothers in other studies.[5,6]

In addition to maternal age, our study corroborated previous findings that parity is often a predictor of the age for CF introduction.[12,13] Studies by Kronborg et al. (2014) and Tang et al. (2015) found that mothers who had previous children were more likely to feed their current child CF later. In support of these findings, the mothers who fed their infants the earliest, were also new mothers, whereas, 62.5% of the mothers who delayed CF until 6 months had introduced CF to another child previously. Possible reasons newer mothers may feed their infants sooner could be because they may have less parenting knowledge and experience, increased anxiety that their children are not getting adequate intake, or increased excitement to share CF with their infants.

Although our study supports the results of previous studies in many cases, they are also several disparities. Unlike other studies, no infants in this study were introduced to CF before 4 months of age. Previous research, such as the IFPS II, have shown as many as 40.4% of infants were introduced before 4 months.[8] Approximately half (55.0%) of mothers in IFPS II noted their reasons for introducing food before 4 months was based on advice from a physician or health care provider. Interestingly, we found that mothers who introduced CF to their infants earlier indicated that their doctor likely influenced their decision. Approximately one-third (37.5%) of mothers who waited until 6 months to introduce their infants to CF reported that they did so because their pediatrician stated that they were old enough compared to 75.0% of mothers who introduced CF at 5 months and half of mothers at 4 months. Given our findings and the findings of the IFPS II it is vital that healthcare providers be aware of the current guidelines for CF. The fact that such a substantial portion of the mothers in the IFPII study introduced their infants to CF early compared to the current study could be the result of the IFPII using data from 2005-2007, whereas this study obtained its data in 2020. The study by Siega-Riz et al. (2010) found that there has been a general trend over time for parents to wait longer to introduce CF.[11] Given

this finding, it is possible that the large discrepancy between early feeding in the IFPSII and this current study could be partially explained by variations in feeding norms at these two different points in time.

Overall, a larger portion of the mothers in our study delayed feeding until 6 months and cited using the recommended time as a reason to begin CF compared to other studies. As previously mentioned, 57.1% of the mothers in our study waited until 6 months to feed their infants CF. In contrast, a study from the United Kingdom (UK) by Brown et al. (2016), found that 19.6% of mothers waited until at least 6 months to introduce CF, with only 14.8% of mothers citing UK Department of Health (DoH) recommendations or developmental readiness as the reason for starting CF.[5] In our study, 42.9% of mothers reported using professional recommendations as an indicator their child was ready to eat CF, and 85.7% of mothers reported using developmental readiness. One reason the two studies could have had such different outcomes is that our study allowed mothers to select as many reasons for CF introduction as they want, whereas the study by Brown et al. allowed respondents to write in one reason. It is possible that if forced to choose, many mothers in our study may have chosen another primary reason. Additionally, differences between the UK and US could have contributed to the different outcomes between these two studies. Although the UK DoH recommends initiating CF around 26 weeks, other European professional organizations, such as ESPGHAN recommend feeding begin between 4 to 6 months, which may have caused some mothers to feed earlier, leading to the discrepancy in the results.

Although our study found that all mothers in this sample were aware of national feeding guidelines, future studies should continue to explore to what degree parents are aware of and value CF feeding guidelines. Furthermore, additional investigation is warranted given several

limitations in our study. The most notable limitation for this study is its small sample size. Because our study only had 14 survey respondents, we were not able to establish statistically significant results. Additionally, because the survey was given to previous Peapod clients, many mothers may have already been counseled and advised on how to introduce CF. In the future, it would be advisable to administer surveys to new clients prior to their first Peapod appointment. The survey may have also been improved if it was administered by a trained interviewer who could have contextualized certain information. For instance, our study found that many mothers initiated CF earlier because of a recommendation from their pediatrician. It would be helpful know why physicians made these recommendations. It is possible physicians were addressing other health conditions such as reflux or that they believed the infants were developmentally ready. The survey being administered in person by a trained interviewer may also have broadened the sample of women who responded to the survey. Because our survey was sent through email and completed online, we may have made it difficult for mothers of lower socioeconomic status to complete the survey. The survey also could have been strengthened by having mothers select a primary reason for introducing CF. The current survey allows mothers to choose as many options as they would like, so their reasons may not exclusively reflect their primary drivers for introducing CF. The strength of this study was the diverse population from which we were able to draw our sample. Peapod serves a diverse array of ages, cultures, and races with differing levels of education and parenting experience. Our small sample did not likely reflect the Peapod population. Therefore, the results are not generalizable.

In conclusion, this study found that many mothers are aware of current CF recommendations, but may choose to feed earlier for a variety of reasons. Future studies

attempting to answer similar questions about infant feeding would benefit from a larger sample size and a longer study duration.

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