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Infant Feeding Practices and Weight Gain in Toddlers Born Very Preterm: A Pilot Study

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ABSTRACT

Purpose: Long-term consequences of prematurity are a public health concern. A pattern of slow initial weight gain followed by a period of rapid weight gain has been associated with poor cardiometabolic health outcomes. The purpose of this study was to examine the relationships between infant feeding practices and weight gain in a sample of 18-to-24-month olds corrected age born very preterm.
Design and Methods: A cross-sectional design was used to examine the relationships between infant feeding practices and weight gain. Estimates of effect sizes and model fit estimates were the primary parameters of interest.
Results: Most of the participants received human milk after birth, but most had transitioned to formula before three months. Slightly less than half received complementary foods prior to four months corrected age. Gains in weight and head circumference were rapid after discharge from the neonatal intensive care unit, while gains in length lagged behind. Infant feeding practices did not have a clinically meaningful effect on weight gain.
Conclusions: While the initiation of human milk feedings was encouraging, the duration fell short of recommendations. Practices such as the early introduction of complementary feedings and the addition of rice cereal to the bottle are troubling. Additionally, the rapid increase in weight gain may have a negative impact on future cardiometabolic health.
Practice Implications.
Clinical recommendations include ensuring support for the use of human milk before and after hospital discharge, close monitoring of physical growth, and ensuring adherence to the guidelines for the introduction of complementary foods.

Prematurity, and its long-term consequences, is a major public health concern. The cost of preterm birth is estimated to exceed $26 billion annually in the United States (March of Dimes, 2018). Short-term health conditions encountered by those born prematurely include respiratory distress syndrome, apnea of prematurity, anemia of prematurity, and necrotizing enterocolitis (Kuehn & Wall, 2015). Long-term, individuals born prematurely are more likely to experience feeding disorders, chronic lung diseases (formerly known as bronchopulmonary dysplasia), asthma, learning difficulties, delayed neurodevelopment, and neurological conditions including cerebral palsy (Centers for Disease Control and Prevention, 2018). Additionally, premature births may be associated with health problems in late childhood and adulthood such as high blood pressure, obesity, and elevated low-density lipoproteins (Parkinson, Hyde, Gale, Santhakumaran, & Modi, 2013).

Despite national efforts to decrease the number of preterm births, the incidence has increased over the past 3 years (Hamilton, Martin, Osterman, Driscoll, & Rossen, 2018). Although the need to reduce the incidence of premature births remains, there is a growing need to address the long-term health outcomes for this vulnerable population. One of the most fundamental long-term health outcomes is appropriate weight gain.

Four patterns of weight gain are visible among individuals who are born prematurely. Most will begin with a pattern of poor weight gain in the NICU (Cooke, 2011; Morgan, Young, McCormick, & McGuire, 2012). After NICU discharge, many infants will gain weight at a steady pace into childhood, although the pattern for a second group shows some initial gains after discharge and then slower weight gain into childhood (Simon et al., 2017). A third pattern creates a group in which the infants struggle to gain weight and who will remain small throughout childhood and adolescence (Hack et al., 2014). Finally, a fourth pattern involves those who experience a rapid gain in weight

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that may result in overweight and obesity during childhood (Hack et al., 2014; Simon et al., 2017). This last pattern is a particular concern as preterm birth with poor weight gain in the NICU followed by rapid weight gain in the first two years of life has been associated with a poor cardiometabolic profile in adulthood (Simon et al., 2017).

Many factors likely influence weight gain in preterm infants, with particular interest given to infant feeding practices. Researchers have noted that human milk feedings have been associated with steady weight gain during the first few months of life in preterm infants (Michels et al., 2017). In comparison, preterm infants that are fed commercially-available term and nutrient-enriched milk tend to experience more rapid weight gain (Michels et al., 2017; Zachariassen et al., 2011). Although there may be short term weight gain benefits with the use of commercially-available milk products, it is unclear whether this weight gain influences long-term health outcomes including future weight gain patterns and eventual development of metabolic disease.

It is also important to consider sources of nutrition besides human and commercially-available milk that are consumed during the first year of life. These non-milk sources of nutrition are termed complementary foods and include any source of food that is not milk (Hagan, Shaw, & Duncan, 2017). For preterm infants, the American Academy of Pediatrics (2017) recommends that complementary foods be introduced based on corrected age (chronological age minus the number of weeks born before term). There is considerable debate, however, over the timing of when to introduce complementary foods in individuals born prematurely. Some researchers and clinicians advocate introducing complementary foods early to promote weight gain and neurodevelopment because premature infants have a high nutrient demand (Barachetti, Villa, & Barbarini, 2017). Other researchers and clinicians promote introducing complementary foods later to guard against weight gain that is considered too rapid and may contribute to cardiometabolic disease later in life (Singhal, 2017). Although this debate persists, little is actually known about when it is best for caregivers of preterm infants to introduce complementary foods. Determining a preferred time to introduce complementary foods is important. Early introduction of complementary foods is associated with greater weight gain and obesity in early childhood and cardiometabolic disease later in life (Hagan et al., 2017).

Theoretical Underpinnings

The theoretical basis for this study derives from work initiated by David Barker (Barker, Eriksson, Forsen, & Osmond, 2002)—it is now referred to as the Developmental Origins of Health and Disease (DOHaD; Wadhwa, Buss, Entringer, & Swanson, 2009). The major features of this theory include that: (a) the fetus adapts to its environment with lifelong health consequences related to a mismatch between the prenatal and postnatal environment, (b) undernutrition in fetal life followed by overnutrition as an infant provides a pathway into obesity in childhood and adulthood, (3) psychobiological stress during pregnancy has an impact on fetal development and later health outcomes, and (4) epigenetic mechanisms have a role in health conditions (Wadhwa et al., 2009).

A common postulate is that metabolic and epigenetic changes are required to promote the survival of the premature infant both in utero and shortly after birth during a period of malnutrition and psychobiological stress (Hoffman, Reynolds, & Hardy, 2017). This has been termed the thrifty phenotype, where an infant adapts physically to survive in a stressful and nutritionally-inadequate environment. These adaptations become problematic when, after NICU discharge, metabolic demand and stress decrease and the infant begins demonstrating robust weight gain. This sequelae of malnutrition and psychobiological stress followed by overnutrition and rapid weight gain has been associated with higher rates of obesity, hypertension, and cardiovascular disease later in childhood and adulthood (Hoffman et al., 2017).

The purpose of this study was to examine the magnitude of associations (i.e., effect sizes) between infant feeding practices and weight gain in a sample of 36 18-to-24-month olds corrected age born very preterm. The research question addressed: The relationships among (1) the use of human milk, (2) the duration of human milk ingestion, (3) the type of commercially-available milk used, (4) the primary source of nutrition prior to the introduction of complementary foods, and (5) the timing of the introduction of complementary foods and weight gain?

Design and Methods

Study Design and Sampling

A cross-sectional, correlational design was used to examine the relationships between infant feeding practices and weight gain for a group of toddlers that were born very preterm (<32 weeks gestation). A convenience sample was recruited from two developmental clinics located in the southeastern United States that focused on delivering follow-up care to children born prematurely and those with other developmental concerns. Participants had to meet the following criteria: (a) 18- to-24 month old toddlers, corrected age; (b) born with a gestational age <32 weeks; (c) born with a birth weight <1500 g; and (d) had a parent who could understand, speak, and read English and who was legally able to consent for the minor child. Exclusion criteria included toddlers with a current or chronic history of (a) congenital heart disease, (b) renal disease, (c) continuous oxygen therapy at home within the last 6 months, and (d) a current diagnosis of failure to thrive. Prior to data collection, approval from appropriate Institutional Review Boards (IRBs) was obtained.

Procedure

Each week, the researcher reviewed appointments for the coming week with clinic staff noting each toddler's current age, gestational age at birth, and birth weight. During the clinic visit, the researcher would approach the parent of eligible toddlers based on the above parameters and explain the purpose of the study. If the parent was interested, the consenting process was completed at that time, after which the parent was interviewed concerning demographic data and past infant feeding practices. Anthropometric data, part of routine data collected at each clinic visit, current and past medical diagnoses, and current medications were abstracted from the clinic chart as per authorization from the parent obtained during the consent process. Upon completion of the study visit, the parent was offered a $10 incentive in the form of a gift card for their participation.

Instrumentation

Anthropometrics

Measurements obtained for this study included the toddler's current weight, length, and head circumference, each of which was retrieved from the health record at the time of the study visit. When available, these same measures were abstracted at birth, time of discharge from the NICU and all clinic visits prior to the visit when parents were recruited and consented.

The birth and discharge measures were plotted on the Fenton Growth Chart, a preterm infant growth chart developed from a multicenter study that includes growth curves for preterm infants from 22 to 50 weeks gestation (Fenton & Kim, 2013). In addition, all clinic visit measures were plotted on the World Health Organization (WHO) growth chart using corrected age. The WHO growth chart is the standard growth chart developed from a multi-national sample and is the growth chart the Centers for Disease Control and Prevention recommends for assessing growth in children 24 months and under (Centers for Disease Control and Prevention, 2013).