The Infant Growth and Development Study: Interdisciplinary Approach to Understanding Early Obesity Risk

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Presentation Outline

- Background & research focus
- Childhood obesity prevention
  - Current knowledge & gaps
- iGrow Study
  - Conceptual model & rationale
  - Methods & procedures
  - Preliminary findings
- Response to COVID-19 & next steps
- Questions

Previous & Ongoing Research Efforts

- Parenting influences on weight outcomes, dietary intake in young children
- Parenting practices related to fruit and vegetables in low-income families with preschoolers

- Social & emotional context of childhood obesity
- Intra- and interpersonal contextual factors associated with childhood obesity
- Maternal feeding practices and weight-control attitudes related to children's weight and body esteem

- Biopsychosocial predictors of adolescent health outcomes
- Childhood self-regulation as a predictor of adolescent health and nutrition outcomes

- Biopsychosocial predictors of obesity risk development in early life
- Maternal prenatal, behavioral and stress-related factors

BACKGROUND: CHILDHOOD OBESITY

- The current rates of childhood obesity in the U.S. (Ogden et al., 2020; Hales et al., 2017)
  - Ages 2-5 years: 13.7%
  - Ages 6-11 years: 19.3%
  - Ages 12-19 years: 20.9%
  - Disparities by SES and race/ethnicity (Ogden et al., 2020)
- Obesity status stable from childhood into adulthood
  - Associated with negative mental, physical and social outcomes (Nader et al., 2005)
  - Existing obesity treatments (Morandi et al., 2019)
  - Over 50% of today's children predicted to be obese by age 35 (Ward et al., 2017)
- Early prevention

BACKGROUND: OBESITY-RELATED RESEARCH DURING INFANCY

- **Infant Weight Gain & Obesity in Early Childhood**
  - Weight gain in the first few months of life (Taveras et al. 2009; Hitze et al., 2010)
  - Rapid infant weight & timing of infant weight gain (Roy et al., 2017; Smego et al., 2016)
- **Feeding Mode**
  - Role of breastfeeding in obesity prevention (Horta et al., 2007; Li et al., 2008; Weng et al., 2012)
  - Nutrient composition and hormonal effects of breastmilk (i.e., satiety) (Koletzko et al., 2009; Oddy, 2012;
- **Solid Food Introduction**
  - "Early" prior to 4 months" (Seach et al., 2010)
- **Other Feeding Practices** associated with negative weight and/or feeding outcomes
  - Feeding on schedule, bottle propping, TV watching while feeding, feeding to soothe (Stifter et al., 2012; Ventura et al., 2019)

OBESITY-RELATED RESEARCH ON FEEDING DURING INFANCY

- **Self-regulation & Obesity Risk**
  - Self-initiated control processes that allow a child to manage physiological, attentional, and emotional arousal (Calkins, 2007; Berge et al., 2007).
  - Important factor in the development of eating behaviors and obesity risk (DiSantis et al., 2011)
    - Emotion regulation linked with emotional eating in school-aged children, suggested as a key target for obesity prevention (Harrist et al., 2013)
    - Emotion regulation associated with adiposity among adolescents, mediated by emotional eating (Shriver et al., 2019)
- **Maternal Sensitivity & Feeding Responsiveness**
  - The promptness and appropriateness of maternal responses to infant signals (Ainsworth et al., 1978)
  - Responsive mothers read infant hunger and satiety cues accurately and respond appropriately
    - Promote infants' awareness of and appropriate response to their internal hunger and satiety cues (DiSantis et al., 2011)
    - Associated with lower overeating, lower risk for overweight and obesity in infancy and later childhood (Spill et al., 2019; Worobey et al., 2009; Anderson et al., 2012]

RESEARCH GAPS: PRENATAL RISKS & INFANT PSYCHOPHYSIOLOGY

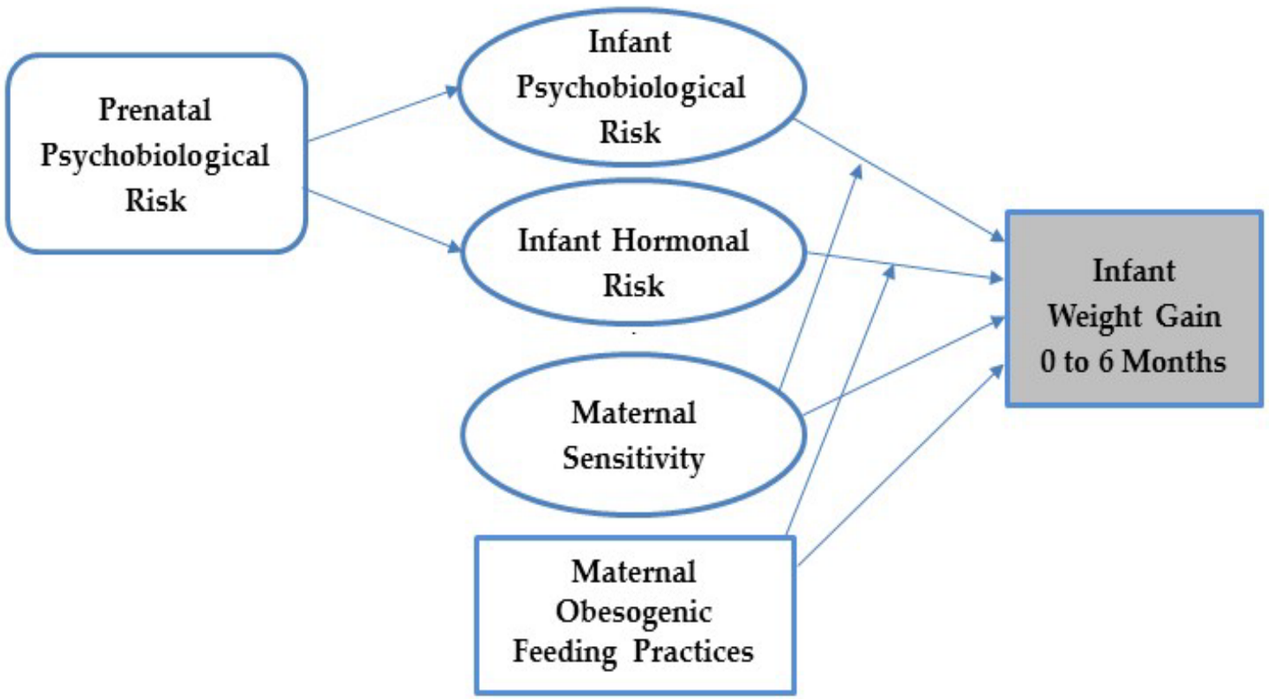
- **Maternal Biological and Psychological Characteristics**
  - Linked to increased obesity risk (Kaar et al., 2014; Hunag et al., 2014)
    - Excessive pregnancy weigh gain; pregnancy complications (T2DM, hypertension); substance use
- **Infant Temperament & Stress Psychophysiology**
  - Temperamental negativity & infant hyperactive stress psychophysiology linked to emotional eating and elevated BMI Infants are easily aroused, highly reactive and more difficult to soothe (O'Connor et al., 2013; Rash et al., 2015)
    - Atypical patterns of cortisol response to stress have been associated with eating in the absence of hunger, emotional eating, and elevated BMI-for-age in childhood and adolescence (Kaciroti & Lumeng, 2013; Tollenaar et al., 2011)
    - Feeding to soothe strategies may contribute to increased risk of obesity over time (Antzman-Frasca et al., 2011; Stifter et al., 2011)
- **Infant Hormonal Risk**
  - Prenatal exposure to maternal hormones: ↑ levels of leptin linked with fetal insulin resistance and ↑ birth weight and adiposity
  - ↑ maternal adiponectin linked with greater birth weight and adiposity but adiponectin levels are negatively associated with BMI in children and adults (Mantzoros et al., 2009; Volberg et al., 2013)

Rationale for the iGrow Project

- **Limitations of obesity-related research in early life**
  - The effects of fetal exposure to prenatal stress on later obesity risk unknown
  - Little research of biological and hormonal risks that likely affect weight outcomes in infants/young children
  - Current knowledge on feeding behaviors and weigh outcomes comes largely from correlational studies
  - Calls for better measures of "obesity risk" in children under age 6
- **Pathways to early childhood obesity largely unknown**
  - Variety of obesity risk factors identified, both prenatally and postnatally
    - Specific mechanisms have not been well investigated
    - Few studies have addressed the developmental complexity of these factors

CONCEPTUAL MODEL

PATHWAYS TO INFANT WEIGHT GAIN BIRTH TO 6 MONTHS



- H1. **Prenatal psychobiological risk** predicts greater infant weight gain in the first 6 months and this effect is explained by:
  - (a) infants' psychobiological risk
  - (b) infants' hormonal risk

- H2. Infant weight gain by 6 months will be predicted by:
  - (a) mother's lower **maternal sensitivity**
  - (b) greater **obesogenic feeding practices** predict greater infant weight gain

- H3. Maternal sensitivity and obesogenic feeding practices as moderators:
  - (a) **Maternal sensitivity** reduces the deleterious effects of infant psychobiological risk on infant weight gain, and
  - (b) **Obesogenic feeding practices** increase the negative effects of infant hormonal risk on infant weight gain.

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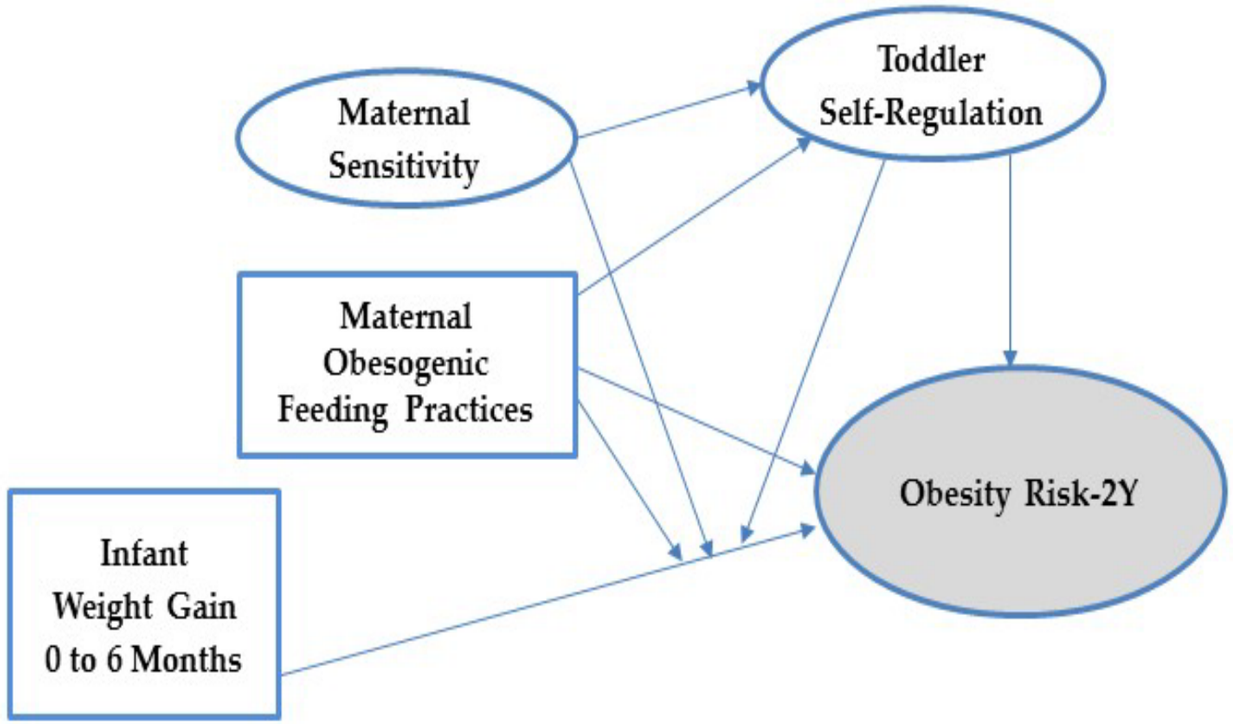
CONCEPTUAL MODEL
PREDICTORS OF OBESITY RISK BY AGE 2



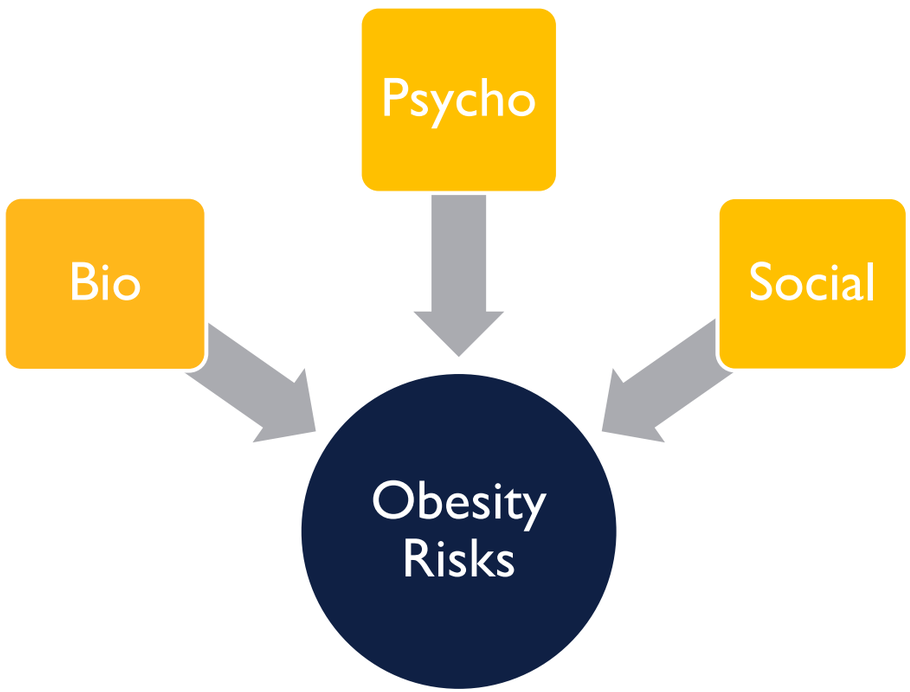
- H1. Greater **infant weight gain by 6 months** predicts greater obesity risk at age 2.

- H2. **Maternal sensitivity** predicts children's lower obesity risk at age 2 by:
  - (a) promoting toddler **self-regulation** (i.e., mediated effect)
  - (b) by moderating (i.e., buffering) the link between infant weight gain and obesity risk at age 2.

- H3. **Obesogenic feeding practices:**
  - a) predict greater obesity risk at age 2 and this link is partially mediated by compromised child self-regulation
  - b) moderate (i.e., exacerbate) the link between infant weight gain and obesity risk at age 2.

- H4. Toddler **self-regulation:**
  - a) moderates (i.e., buffer) the link between infant weight gain and obesity risk

Interdisciplinary Approach



Study Significance

- Our *biopsychosocial perspective* will inform basic science about early life processes and how they causally relate to obesity risk development

- Development of targeted interventions and preventive approaches that consider mother, infant, as well as family risks and resources

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Recruitment & Inclusion/Exclusion Criteria

- Recruitment goal: 300 pregnant women in their 3rd trimester
- Guilford County, NC
- Inclusion & exclusion criteria
  - Mothers are 18 or older, expecting a singleton, fluent in English, and planning to remain in the region for 3 years
  - Infants with birth defects or metabolic disorders, gestational age < 37 weeks, or birth weight < 2500 grams will be excluded
- Recruitment procedures & locations
  - WIC clinics; Cone Health Hospital; OBGYN offices
  - Radio ads & in public transit, Twitter, Facebook
- Incentives of $405 per participants

Study Design & Procedures

- ✓ Prospective longitudinal design
- ✓ 5 data collection points; multi-method
- ✓ Home visits and lab visits
  - ✓ 1.5-2 hours
- ✓ Maternal reports of demographics, stress, well-being, feeding practices and child characteristics and health
- ✓ Direct observation of maternal and infant behavior during feeding, play, and distress-eliciting tasks
- ✓ Anthropometric measures
  - ✓ Weight, length, skinfolds & circumferences
- ✓ Assays of prenatal blood and infant saliva and urine

Prenatal lab visits

2-M home visit

6-M lab visit

12-M lab visit

2-Y lab visit

Study Measures

Maternal Data

- ✓ Demographic & SES information
- ✓ Family and household characteristics
- ✓ Biological specimen
  - ✓ Blood samples
- ✓ Behavioral data
  - ✓ Self-reported data
  - ✓ Observational data
- ✓ Anthropometrics
- ✓ Accelerometry
- ✓ Dietary screeners (NCI)
- ✓ Eating Behaviors (DEBQ) (Van Strien et al., 1986)

Infant Data

- ✓ Biological specimen
  - ✓ Saliva samples for cortisol
  - ✓ Urine samples for hormones
- ✓ Feeding-related data
  - ✓ Infant Feeding Practices Q. (Fein et al., 2008)
  - ✓ Infant Feeding Style Q. (Thompson et al., 2009)
  - ✓ Observational feeding interaction data
  - ✓ Self-regulation
- ✓ Anthropometrics
  - ✓ Weight, length, and skinfolds

Preliminary Analyses

Aims:

- Examine feeding-related infant characteristics and maternal food-related behaviors in a sub-sample of iGrow participants
- Identify potential associations between maternal feeding styles and infant weight outcomes at 6M in this sub-sample

Table 1. Maternal & Family Characteristics

		Total (n=164)
Maternal factors		
	Maternal age, years, mean (SD)	29.2 (5.99)
	Pre-pregnancy BMI (kg/m)[a]	28.5 (7.68)
	Diagnosis of Gestational Diabetes[b]	9 (7.8%)
Maternal Race[c]		
	White	78 (48.4)
	Black	57 (35.4)
	Multiracial/other	26 (16.1)
Ethnicity.	Hispanic	12 (7.4)
Maternal Education[d]		
	High school or below	34 (21.1)
	Some college	38 (23.6)
	College degree or above	89 (55.7)
Household Income[e]		
	Less than $25,000/year	56 (35.2)
	$25,000-$44,999	30 (19.2)
	$50,000-$99,999	41 (26.2)
	Greater than $100,000/year	30 (19.2)
Relationship Status[f]		
	Married/Serious relationship	136 (84.0)
	Separated/Divorced	3 (1.8)
	Single	23 (14.2)
Parity		
	Primiparous	74 (45.1)

Note: Data presented as n (%) except as noted; [a] Missing for n = 49; [b] Missing for n = 48; [c] Missing for n = 3; [d] Missing for n = 2; [e] Missing for n = 7; [f] Missing n = 2

Table 2. Infant Characteristics

	Total (n=150)	Race		
		White (n=74)	**Black (n= 51)**	**Multiracial/Other (n=25)**
Infant factors				
Gender, female	75 (50)			
Birth weight, kg, mean (SD)[a]	3.37 (0.48)	3.49 (0.48)	3.21 (0.45)	3.33 (0.48)
Birth length, cm, mean (SD)[b]	50.44 (2.47)	50.79 (2.30)	50.19 (2.49)	49.79 (2.85)
Weight-for-length percentile at 2M	53.91 (32.25)	51.89 (33.17)	57.53 (31.09)	53.02 (32.68)
Ever breastfed	141 (94.0)	71 (95.9)	46 (90.2)	24 (96.0)
Completely stopped breastfeeding by 2 months	32 (21.3)	10 (14.1)	15 (32.6)	7 (29.2)
Feeding Mode at 2 months				
Breastfeeding	70 (46.7)	43 (58.1)	14 (27.5)	13 (52.0)
Formula Feeding	38 (25.3)	11 (14.9)	18 (35.2)	4 (16.0)
Mixed Feeding	42 (28.0)	20 (27.0)	19 (37.3)	8 (32.0)
Early introduction of solid foods[c]	15 (9.1)	3 (4.1)	9 (17.6)	3 (12.0)

Note: Data presented as n (%)

[a] missing data for n=9, [b] missing data for n=15, [c] < 4 months

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Table 3. Unadjusted Infant Feeding Style Scores at 2 Months (mean ± SD)

	Total (n=146)	White (n=73)	Black (n=50)	Multiracial/other (n=23)
Laissez-Faire: Total Score	2.00 ± 0.53	1.93 ± 0.46	2.13 ± 0.53	1.94 ± 0.47
Attention	2.03 ± 0.69	1.90 ± 0.62*	2.23 ± 0.78*	1.99 ± 0.65
Diet quality	1.97 ± 0.67	1.95 ± 0.65	2.04 ± 0.68	1.90 ± 0.75
Pressuring/Controlling: Total Score	2.20 ± 0.53	2.04 ± 0.48*	2.38 ± 0.57*	2.29 ± 0.44
Finishing	2.12 ± 0.77	1.98 ± 0.71	2.30 ± 0.87	2.17 ± 0.75
Cereal	1.78 ± 0.84	1.43 ± 0.62*	2.22 ± 0.94*	1.93 ± 0.80*
Soothing	2.70 ± 0.70	2.71 ± 0.69	2.63 ± 0.73	2.79 ± 0.72
Restrictive: Total Score	1.51 ± 0.50	2.97 ± 0.58*	3.29 ± 0.63*	3.32 ± 0.65*
Amount	2.90 ± 1.01	2.43 ± 0.84*	3.53 ± 0.87*	3.04 ± 0.87*
Diet Quality	3.39 ± 0.84	3.51 ± 0.83*	3.07 ± 0.79*	3.63 ± 0.85*
Indulgent: Total Score	3.14 ± 0.63	1.41 ± 0.43*	1.74 ± 0.59*	1.35 ± 0.33*
Permissive	1.94 ± 0.74	1.78 ± 0.62*	2.29 ± 0.86*	1.70 ± 0.54*
Coaxing	1.40 ± 0.56	1.32 ± 0.49*	1.62 ± 0.69*	1.23 ± 0.34*
Soothing	1.34 ± 0.53	1.24 ± 0.43*	1.54 ± 0.67*	1.24 ± 0.33*
Pampering	1.34 ± 0.53	1.24 ± 0.42*	1.53 ± 0.65*	1.30 ± 0.46
Responsive: Total Score	4.07± 0.57	4.06 ± 0.51	4.03 ± 0.67	4.19 ± 0.53
Satiety	4.50 ± 0.51	4.59 ± 0.45*	4.31 ± 0.61*	4.60 ± 0.36*
Attention	3.64± 0.96	3.53 ± 0.89	3.75 ± 1.02	3.83 ± 1.06

PRELIMINARY FINDINGS: FEEDING STYLES BY RACE AND FEEDING MODE

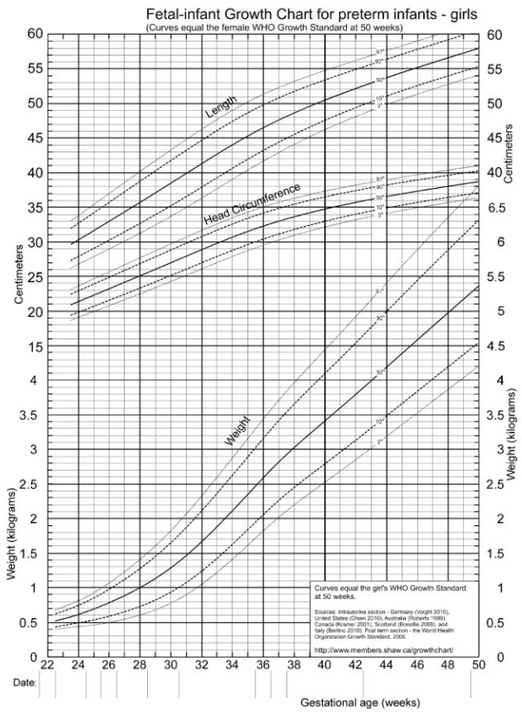
- The only differences in feeding style by race observed in **indulgent feeding**
  - After controlling for maternal income, education, age, infant birth weight and relationship status, initial differences detected in pressure/controlling and restrictive feeding styles by race diminished
  - Black mothers scored higher (1.74 ± 0.59) on indulgent feeding compared to White (1.41 ± 0.43) and multiracial/other mothers (1.35 ± 0.33) at p=0.001
- Feeding styles by feeding mode
  - Two categories by feeding mode (exclusively breastfed vs. formula/mixed feeding)
  - Mothers of exclusively breastfed infants
    - Lower scores on restrictive feeding style (2.96 ± 0.53 vs. 3.31 ± 0.67; p=0.02)

PRELIMINARY FINDINGS: FEEDING STYLES BY RACE AND FEEDING MODE

- **Exclusively breastfed infants**
  - Black mothers scored higher on Laissez-Faire feeding ($p=0.04$) & pressure/controlling feeding compared to White mothers ($p=0.03$)
  - Differences diminished once controlling for maternal education, income, age, birthweight and relationship status
- **Formula/mixed fed infants**
  - Black mothers had similar scores as White mothers on indulgent feeding and their scores were higher compared to multiracial/other mothers ($p<0.05$)
  - Differences remained even after controlling for covariates (see above)
    - Model: $R^2 = 0.20$; $F=2.19$; $p<0.05$

FEEDING STYLES AS PREDICTORS OF 6M WEIGHT OUTCOMES

- Linear regression models with 6M weight-for-length z-scores as DV with the 5 feeding styles as predictors
  - Covariates: maternal age, income, education, relationship status, infant birthweight
- Model significant with Laissez-Faire feeding style as a predictor [R=0.35; F=2.92(5, 103); p<0.05]
  - Higher scores on Laissez-Faire (LF) feeding associated with greater weight-for-length z-scores at 6 months (β =0.74; p<0.01)
  - Interaction between LF feeding and race approached significance at p=0.06
- Other feeding styles were not significant predictors of weight-for-length z-scores at 6 months
  - Indulgent, responsive, restrictive, pressure/controlling



DISCUSSION

- Research on obesity-related feeding practices and styles comes primarily from samples of preschoolers & children
- Interesting trends in feeding styles in our racially and socioeconomically diverse sample
  - Black mothers less likely to breastfeed in our sample; 2020 NC Women Health Report Card (73% of Black mothers initiate breastfeeding compared to 96% of Hispanic mothers; 48% breastfeed some at 2 months)
  - Lower restriction among exclusively breastfed infants support previous findings (Khalsa et al. 2019)
  - Higher scores on indulgent feeding among Black mothers
- Feeding styles & infant weight gain
  - In our sub-sample, Laissez-Faire feeding style associated with higher infant weight at 6 months
  - Mothers scoring high on Laissez-Faire feeding did not keep track of how much milk their infant drank at 3 months, which in turn was associated with earlier introduction of solid food and thus greater weight gain (Rogers & Blissett, 2018)
- Future Analyses
  - Consider additional factors that may influence the use of specific feeding practices in our sample (i.e., food insecurity, prenatal stress, maternal concerns about child weight)
  - Examine associations between feeding practices and styles and weight outcomes in our full sample at 6 months

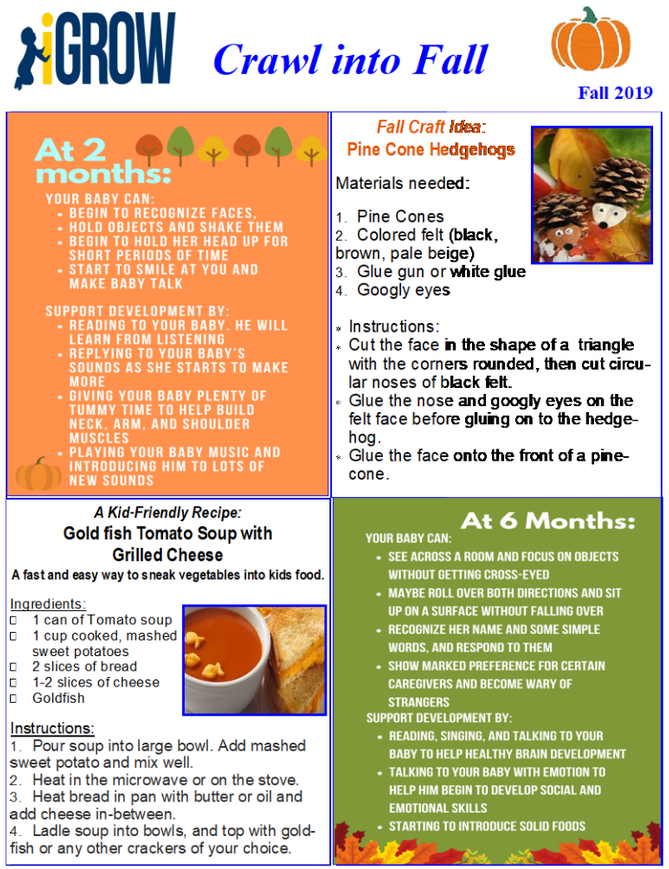
Impacts of COVID-19 on iGrow Study

iGrow Recruitment Goal = 300
Currently Enrolled = 189

Impacts of COVID-19 on iGrow Study

- **New study procedures**
  - 2M home visits revised to lab visits
  - Timing of 6M visits revised
  - Safety precautions and screenings
  - Personal Protective Equipment (PPE) for iGrow staff
  - Timing between visits in the lab
- **Staff & students**
  - Potential exposures; 14-day quarantine
- "Ramp-up Research" plans submitted to the University
  - Consultants from medical/clinical settings
- Response from iGrow participants

NEWSLETTERS: BEFORE COVID-19 PANDEMIC AND NOW



iGROW *Crawl into Fall*

Fall 2019

At 2 months:

YOUR BABY CAN:
- BEGIN TO RECOGNIZE FACES,
- HOLD OBJECTS AND SHAKE THEM
- BEGIN TO HOLD HER HEAD UP FOR SHORT PERIODS OF TIME
- START TO SMILE AT YOU AND MAKE BABY TALK

SUPPORT DEVELOPMENT BY:
- READING TO YOUR BABY. HE WILL LEARN FROM LISTENING
- REPLYING TO YOUR BABY'S SOUNDS AS SHE STARTS TO MAKE MORE
- GIVING YOUR BABY PLENTY OF TUMMY TIME TO HELP BUILD NECK, ARM, AND SHOULDER MUSCLES
- PLAYING YOUR BABY MUSIC AND INTRODUCING HIM TO LOTS OF NEW SOUNDS

Fall Craft Idea:
Pine Cone Hedgehogs

Materials needed:

1. Pine Cones
2. Colored felt (**black**, brown, pale beige)
3. Glue gun or **white glue**
4. Googly eyes

- Instructions:
- Cut the face **in the shape of a triangle** with the corners **rounded, then cut** circular noses of **black felt.**
- Glue the nose **and googly eyes on the** felt face before **gluing on to the** hedgehog.
- Glue the face **onto the front of a pine**cone.

A Kid-Friendly Recipe:
Gold fish Tomato Soup with Grilled Cheese

A fast and easy way to sneak vegetables into kids food.

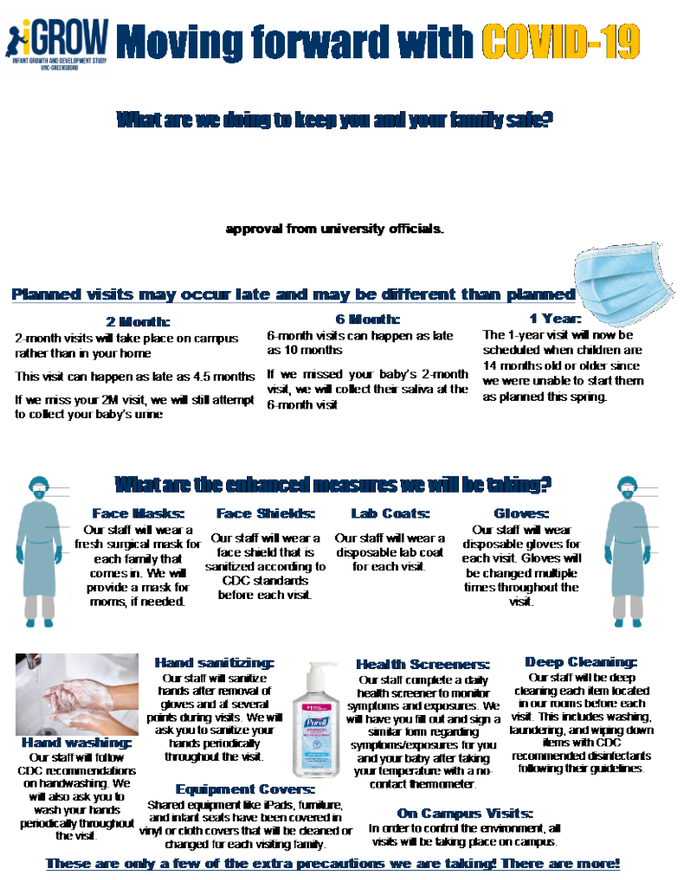
Ingredients:
- ☐ 1 can of Tomato soup
- ☐ 1 cup cooked, mashed sweet potatoes
- ☐ 2 slices of bread
- ☐ 1-2 slices of cheese
- ☐ Goldfish

Instructions:
1. Pour soup into large bowl. Add mashed sweet potato and mix well.
2. Heat in the microwave or on the stove.
3. Heat bread in pan with butter or oil and add cheese in-between.
4. Ladle soup into bowls, and top with goldfish or any other crackers of your choice.

At 6 Months:

YOUR BABY CAN:
- SEE ACROSS A ROOM AND FOCUS ON OBJECTS WITHOUT GETTING CROSS-EYED
- MAYBE ROLL OVER BOTH DIRECTIONS AND SIT UP ON A SURFACE WITHOUT FALLING OVER
- RECOGNIZE HER NAME AND SOME SIMPLE WORDS, AND RESPOND TO THEM
- SHOW MARKED PREFERENCE FOR CERTAIN CAREGIVERS AND BECOME WARY OF STRANGERS

SUPPORT DEVELOPMENT BY:
- READING, SINGING, AND TALKING TO YOUR BABY TO HELP HEALTHY BRAIN DEVELOPMENT
- TALKING TO YOUR BABY WITH EMOTION TO HELP HIM BEGIN TO DEVELOP SOCIAL AND EMOTIONAL SKILLS
- STARTING TO INTRODUCE SOLID FOODS



iGROW **Moving forward with COVID-19**

What are we doing to keep you and your family safe?

approval from university officials.

Planned visits may occur late and may be different than planned

2 Month:
2-month visits will take place on campus rather than in your home

This visit can happen as late as 4.5 months

If we miss your 2M visit, we will still attempt to collect your baby's urine

6 Month:
6-month visits can happen as late as 10 months

If we missed your baby's 2-month visit, we will collect their saliva at the 6-month visit

1 Year:
The 1-year visit will now be scheduled when children are 14 months old or older since we were unable to start them as planned this spring.

What are the enhanced measures we will be taking?

Face Masks:
Our staff will wear a fresh surgical mask for each family that comes in. We will provide a mask for moms, if needed.

Face Shields:
Our staff will wear a face shield that is sanitized according to CDC standards before each visit.

Lab Coats:
Our staff will wear a disposable lab coat for each visit.

Gloves:
Our staff will wear disposable gloves for each visit. Gloves will be changed multiple times throughout the visit.

Hand washing:
Our staff will follow CDC recommendations on handwashing. We will also ask you to wash your hands periodically throughout the visit.

Hand sanitizing:
Our staff will sanitize hands after removal of gloves and at several points during visits. We will ask you to sanitize your hands periodically throughout the visit.

Equipment Covers:
Shared equipment like iPads, furniture, and infant seats have been covered in vinyl or cloth covers that will be cleaned or changed for each visiting family.

Health Screeners:
Our staff complete a daily health screener to monitor symptoms and exposures. We will have you fill out and sign a similar form regarding symptoms/exposures for you and your baby after taking your temperature with a no-contact thermometer.

On Campus Visits:
In order to control the environment, all visits will be taking place on campus.

Deep Cleaning:
Our staff will be deep cleaning each item located in our rooms before each visit. This includes washing, laundering, and wiping down items with CDC recommended disinfectants following their guidelines.

These are only a few of the extra precautions we are taking! There are more!

https://igrow.uncg.edu/

NEXT STEPS

Restart recruitment and data collection from pregnant women (Cohort II)

Begin data analyses examining 6-month weight outcomes

Prepare for data collection at Age 2

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  - Esther Leerkes, PhD-HDFS
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  - Megan Chandler, MS
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- Women and children participating in the iGrow study

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