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Household chaos during infancy and infant weight status at 12 months

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Abstract

Background: Infancy is a critical period for obesity prevention. Emerging evidence links household chaos to poor health outcomes, yet its impact on obesity in infancy is unknown.

Objectives: We examined associations between household chaos when infants were 6 and 12 months and weight-for-length (WFL) *Z*-score at 12 months, exploring potential mediation by infant sleep and screen time.

Methods: We examined 401 predominately black women and infants in the southeastern United States. We conducted multivariable linear regressions examining household chaos and infant WFL *Z*-score, assessing breastfeeding, sleep, screen time as potential mediators.

Results: Among infants, 69.7% were black and 49.0% were female. Mean breasting duration was 3.7 months. Over half (50.4%) of families had annual household incomes <$20,000. After adjustment for potential confounders, household chaos was associated with infant WFL *Z*-score (0.02; 95% CI 0.001, 0.04; P=0.04) at 12 months. We did not observe associations between chaos and infant breastfeeding, sleep, or screen time.

Conclusions: Higher household chaos was associated with greater infant weight at 12 months, but there was no evidence of mediation by breastfeeding, sleep, or screen time.

Keywords

chaos; home environment; infant; obesity; screen time; sleep

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Introduction

Household chaos, defined as chaotic living due to high levels of disorganization, overcrowdedness, noise, lack of routine, and unpredictability in daily activities, has been linked to physical, emotional, and functional problems in childhood.[1] Household chaos may affect children's development and health behaviors related to obesity risk as well as emotional, behavioral and social functioning.[2,3] A recent study found that adolescents in more chaotic households experienced higher odds of nighttime sleep disturbances.[4] In a second study of low-income families at risk for obesity, higher family chaos was associated with poor emotional and behavioral functioning, as well as sleep problems in children.[5] There is also some evidence that household chaos moderates the relationship between executive functioning and impulse control in parents.[6] In children and adolescents with type I diabetes mellitus, greater maternal and paternal chaos ratings were negatively associated with glycemic control.[6] In a prior study of younger children, researchers found that in more chaotic home environments, infants experienced greater social and emotional developmental problems when they entered preschool.[7] Thus, it is possible that household chaos has a negative impact on multiple aspects of children's development and health.

Household structure and routines may play a role in promoting healthy behaviors (e.g., longer breastfeeding, adequate sleep, and limited to no screen time) among young children. Household routines like regular family meals, fixed sleep schedules, and limited screen time have been associated with decreased obesity in children.[8] However, the impact of chaos on children's obesity risk remains understudied. To our knowledge, only one study examined the effects of household chaos on obesity in children. A study of children ages 6–13 years linked household chaos with lower caregiver screen time monitoring, inconsistent bedtime routines, and the presence of a television in children's bedrooms to obesity through mediation by screen time and sleep duration.[9] In prior studies of infants, screen time has been associated with decreased sleep duration and a delay in sleep onset.[10] Thus, there is some evidence that household chaos could be associated with both sleep duration and screen time – even in infancy.

Weight gain trajectories during infancy are associated with early childhood obesity and early childhood obesity are important predictors of obesity risk in adulthood.[11] Thus, understanding the potential role of household chaos on weight gain during infancy is needed to inform evidence-based interventions and early preventions. The goal of our study was to evaluate associations between household chaos when infants were 6 and 12 months of age and weight status at 12 months. We were also interested in examining whether this relation – if one existed – was mediated by infant breastfeeding, sleep, or screen time. In secondary analyses, we examined the effect of chaos at 6 months on infant weight status at 9 and 12 months. We hypothesized that more chaotic home environments would be associated with higher weight-for-length z-scores and that this relationship would be mediated by infant breastfeeding, sleep, and screen time.

Methods

Study Design and Population

Subjects were participants in the Nurture study, a birth cohort of predominately black women and their infants residing in the southeastern United States. The goal of the Nurture study is to identify factors related to feeding, activity, and sleep that contribute to excessive weight gain in infancy, focusing on the role of various caregivers. Between 2013 and 2015, we enrolled women in either the second or third trimester of pregnancy, interviewed them by phone shortly after birth, and conducted a home visit when their infants were 3, 6, 9, and 12 months of age. Additional information about the Nurture study is available elsewhere.[12] Women provided written informed consent at enrollment in pregnancy, and verbally confirmed their continued interest during a telephone call with the research team shortly after birth. The human subjects committee of Duke University Medical Center approved this study and its protocol.

Of the 666 women who enrolled their infants in the Nurture study after birth, 535 (80.3%) completed the 3-month home visit, 497 (74.6%) completed the 6-month home visit, 457 (68.6%) completed the 9-month home visit, and 468 (70.3%) completed the 12-month home visit. We excluded 265 infants with missing data on the outcome, exposure, or covariates, leaving a total analytic sample of 401. We compared the 666 mother-infant dyads in the larger enrolled sample with the 401 included in the analytic sample. We found that 51.1% of infants in the overall sample were male, compared to 47.9% in the analytic sample. Also, 69.7% in the overall sample were black versus 63.3% in the analytic sample. Additionally, mean (standard deviation, SD) birth weight for gestational age Z-score was the same for both groups of infants (−0.3 (0.9) in the overall sample and −0.3 (1.0) in the analytic sample). Among mothers, 47.8% had a high school diploma or less, compared to 43.6% of mothers in the analytic sample.

Exposure: Chaos in the home

Our primary exposure was chaos at home, measured using the Confusion, Hubbub and Order Scale (CHAOS) measure[1] when infants were 6 and 12 months. The CHAOS measure includes 15 items (e.g., “we almost always seem to be rushed”, “you can’t hear yourself think in our home”, “no matter how hard we try, we always seem to be running late”), each scored on a 4-point Likert scale ranging from “very much like our own home” to “not at all like our own home”. The final score represents a sum of all responses. Based on the scoring, the minimum and maximum attainable values of chaos were 15 and 60, respectively.[1] Higher CHAOS scores indicate greater confusion and disorganization in the home environment.[1] The CHAOS scale has been tested for reliability and has been validated against direct observations of parental and household behaviors.[1] Chaos is a dynamic exposure that can vary over a relatively short period of time.[13] Additionally, infancy is a period of rapid development (e.g., motor development, feeding); parental functioning and caregiving responsibilities may change as well. We sought to provide a cumulative measure of household chaos during the second half of infancy. We computed average household chaos at 6 and 12 months, the two time periods that we measured during the Nurture study. This summary measures is consistent with a previous study examining chaos over time from infancy to early childhood.[13]

Outcome: Infant weight-for-length z-score

The primary outcome of interest was infant weight-for-length *Z*-score at 12 months; a secondary outcome was infant weight-for-length *Z*-score at 9 months. Trained research assistants measured infant weight and length in triplicate during a home visit, taking an average of the 3 measurements. We calculated weight-for-length *Z*-scores using World Health Organization age-and sex-specific reference data.

Other measures

We collected demographic information from mothers via interviews and questionnaires at recruitment, at birth, and during each home visit. We abstracted information on infant birth weight in grams and length in centimeters from the medical record. Infant variables of interest included age, sex, race (black, white, and other race or more than one race) and birth weight for gestational age as a continuous *Z*-score. We calculated birth weight for gestational age *Z*-score using international reference data put forth by Intergrowth-21st Newborn Birth Weight Standards and Z Scores. Maternal variables of interest included age, education (less than or equal to high school graduate, and more than high school), marital status (married or living with a partner, and never married, divorced, separated or others) and pre-pregnancy body mass index (BMI) as a continuous variable (either self-reported or extracted from the medical record). We also documented breastfeeding at 3, 6, 9, and 12 months and calculated the total number of months of any breastfeeding for each infant. Household variables of interest included household income (median split <$20,000 or ≥ $20,000), and number of adults and children in the household as continuous variables. Additionally, mothers reported infants' total sleep duration over 24 hours and total screen time averaged over one week (including videos, television, and using mobile interactive technologies) at 6 and 12 months.

Analysis

We calculated the mean (standard deviation; SD) for continuous demographic variables and percentages for categorical variables. For the primary aim, we fitted multivariable linear regression model to estimate the association between household chaos at 6 and 12 months and weight-for-length z-score at 12 months. We adjusted for covariates that were of *A PRIORI* interest, including infant age, race, sex, birth weight for gestational age *Z*-score; maternal age, education, marital status, and pre-pregnancy body mass index; number of adults in the household, number of children in the household, and household income; and any breastfeeding duration. We validated model assumptions using residual and collinearity diagnostics. In cases where the normality assumption was violated, we transformed the outcome variable accordingly.

Next, we applied the approach of Baron and Kenny[14] and MacKinnon[15] to assess whether the effect of household chaos was mediated by infant breastfeeding, sleep duration, and screen time. This approach involves fitting a series of regression equations: a regression of outcome on exposure, a regression of mediator on exposure, and a regression of outcome on exposure plus mediator. To show mediation, we need to establish an association between chaos and weight- for-length z-score, an association between chaos and breastfeeding, sleep, or screen time, and an association between breastfeeding, sleep, or screen time and weight-for-length z-score, controlling for chaos. Lastly, we look for a change in the effect size between chaos and weight for length z-score before and after adjusting for breastfeeding, sleep, or screen time. Failure to establish a significant association at any of these stages halts the process and indicates no evidence of mediation.

Secondarily, we examined the effect of 6-month chaos jointly on infant weight-for-length z-score at 9 and 12 months. To account for the correlation between infant weight-for-length at 9 and 12 months, we fit a repeated measures linear regression model with exchangeable correlation structure, adjusting for the same covariates described above. We present results in terms of parameter estimates, 95% CI, and two-sided *P* values. We conducted all analyses using SAS 9.4 (SAS Institute, Cary, North Carolina, USA) at a significance level of <0.05.

Results

Forty-nine percent of infants included in the study were female and 51% were male (Table 1). The mean (SD) birth weight for gestational age z-score was −0.3 (0.9). Among infants, 69.7% were black and 15.2% were white. Mean (SD) household chaos was 24.3 (6.4) at 6 months and the range was 15–51. At 12 months, mean (SD) chaos was 25.1 (6.7) with a range of 15–52. Mean (SD) breastfeeding duration over the first year was 3.7 (4.6) months. Mean (SD) sleep duration for infants was 13.0 (2.3) (range 4–17) and 12.6 (1.8) hours (range 6–16) per day at 6 and 12 months, respectively. Mean screen time was 2.1 (5.3) hours (range 0–16.4) at 6 months and 2.3 (5.5) hours (range 0–14.1) per week at 12 months. Mean (SD) weight-for-length z-score at 9 months was 0.6 (1.0) and at 12 months was 0.6 (1.0). Just under half of women (47.8%) had a high school diploma or less, 58.8 were married or living with a partner, and about half (50.4%) had household incomes less than $20,000 per year.

After adjustment for potential confounders, higher household chaos averaged between 6 and 12 months was marginally associated with increased infant weight-for-length *Z*-score at 12 months (0.02; 95% CI 0.001, 0.04; *P*=0.04) (Table 2). Based on this model, for every 10-unit increase in household chaos score, infant weight-for-length *Z*-score increased by 0.20 units, on average. Some covariates identified *A PRIORI* were significantly associated with the outcome, including infant birth weight for gestational age z-score (0.21; 95% CI 0.10, 0.32; *P*<0.001), pre-pregnancy BMI 0.02; 95% CI 0.003, 0.03; *P*=0.01) and number of people in the household (−0.10; 95% CI - 0.18, −0.02; *P*=0.02). Similarly, number of adults in the household and number of children in the household were the only covariates associated with the exposure (data not shown). We did not observe an association between household chaos and infant breastfeeding (−0.02; 95% CI −0.16, 0.13; *P*=0.82), sleep (0.03; 95% CI −0.15, 0.20; *P*=0.79), or screen time (15.33; 95% CI −7.49, 38.15; *P*=0.12). Therefore, the second regression equation in the mediation process could not be established. Hence, we did not further pursue the analysis examining breastfeeding, sleep duration, or screen time as possible mediators in the relationship between household chaos and infant weight-for-length z-score. In secondary analyses, household chaos was associated with infant WFL *Z*-score at

9 months (0.02; 95% CI 0.002, 0.03; P=0.03) but this effect was attenduated at 12 months (0.01; 95% CI −0.002, 0.03; P=0.09) (Table 2).

Discussion

We found that greater household chaos between 6 and 12 months of age was associated with increased infant weight status at 12 months. In secondary analyses, household chaos at 6 months was associated with increased infant weight status at 9 but not 12 months. These findings suggest that measuring chaos at a single time point may be insufficient for assessing its longer term effect on infant weight—even over a relatively short period of time. Instead, multiple assessments over time may be needed, as infancy is a dynamic time for both infants and their families. Additionally, we attempted to compare mean chaos scores in our sample of infants to those published in previous studies of older children and found only one study that published chaos scores. Chaos scores in our study are similar to those reported in a prior study of adolescents.[16] However, few previous studies have published their mean household chaos scores, so it is diffifult to assess how chaos in households with infants compare to chaos scores found in studies of older children.

These findings warrant further exploration, as household chaos may be indicative of other stressors in the home environment. For example, household chaos has been associated with poverty[16] and social and economic vulnerability within families.[17] There is some early evidence that household chaos may be associated with maternal executive function,[18] which is in turn associated with negative caregiving and parenting behaviors.[19] Higher executive function in mothers has also been linked to more responsive infant feeding.[20] It is therefore possible that household chaos impacts infant weight status through parenting and feeding practices if mothers living in more chaotic households are less likely to engage in responsive feeding. Future studies could explore the extent to which household chaos is associated with infant feeding practices other than breastfeeding, and responsive feeding in particular. Additionally, household chaos has been associated with young children’s executive function[19] and executive function has been linked to childhood obesity.[21] In a previous study of infants, researchers also reported associations between higher levels of chaos within the home and infant frustration and distress to limitations.[22] However, we did not have measures of maternal or infant executive function within our study.

Instead, we examined infant sleep and screen time as potential mediators, as there was some prior support for this hypothesis,[9] but did not observe associations. These findings are contrary to our hypothesis – we anticipated that shorter infant sleep duration, for example, might mediate the relationship between higher household chaos and increased infant weight status. However, in our study, there was little variation in infant sleep duration, which could explain the lack of association between chaos and sleep and screen time. We also used maternal report of infant sleep duration, which may not have accurately captured the true amount of sleep time. Sleep duration has been associated with obesity in children in prior longitudinal studies.[23] Even in infancy, researchers have observed a relationship between sleep and obesity.[24] Most previous studies have used maternal report, but more objective measures of infant sleep may be needed.

We hypothesized that screen time, including videos, television, and mobile interactive technologies, might mediate this relationship. Excessive screen time has been associated with sleep problems, language delays, and impaired cognitive development in early childhood.[25,26] Screen time has also been associated with overweight and obesity in children in prior studies.[27] Even in infancy, screen time has been associated with decreased sleep duration and a delay in sleep onset,[10] distracted and unfocused play,[28] and increased television viewing[29] later in childhood. However, chaos was not associated with screen time in our sample. It is possible that for infants, negative consequences of reduced sleep or increased screen time takes time to reveal. That is, a 6-month time frame may not have been sufficient to observe the mediating effect of reduced sleep duration or increased screen time on household chaos and weight-for-length z-score. Therefore, it may be necessary to follow infants for a longer duration of time to assess the relationship between reduced sleep duration, increased screen time, and obesity. Also, measurement bias may have attenuated the mediation analysis results. Mothers with high level of exposure to chaos may be less likely to recall infant sleep or screen time accurately, compared compared to those living in a less chaotic home environment.

There are some limitations to this study. First, the Nurture participants analyzed here were not entirely representative of the larger population. Women participating in the study attended one of two obstetric clinics that served a high percentage of low-income women. One clinic in particular cared for a large proportion of non-Hispanic white women with high-risk pregnancies. The demographic composition of our sample also included a higher representation of non-Hispanic black women than the local population, which can limit generalizability. Additionally, there was attrition during the course of the study. From birth to the 12-month assessment, approximately 29% of mothers withdrew or were lost to follow-up. This retention rate is not unusual. In a similar birth cohort from the same geographic region, attrition rates at the 12- month follow-up were 56%.[30] However, the analytic sample in this study was not unlike the overall sample in terms of demographic characteristics.

In our study, higher household chaos in the second half of infancy was associated with greater infant weight at 12 months, but there was no evidence of mediation by breastfeeding, sleep, or screen time. These results represent modest, but perhaps important differences in infant weight status. Over time, the cumulative effect of chaos may have a more substantial influence on child weight if households remain choatic.

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Abbreviations:

BMI	body mass index
US	United States

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Table 1.

Characteristics of mothers and infants participating in the Nurture study (n=666)

Infant Characteristics	***Mean (SD)***
Birth weight for gestational age *z*-score	−0.3 (0.9)
Age at 9-month home visit, months	9.5 (0.5)
Age at 12-month home visit, months	12.5 (0.8)
Weight-for-length *Z*-score at 9 months	0.6 (1.0)
Weight-for-length *Z*-score at 12 months	0.6 (1.0)
Any breastfeeding, months	3.7 (4.6)
Sleep duration at 6 months, hours per day	13.0 (2.3)
Sleep duration at 12 months, hours per day	12.6 (1.8)
Screen time at 6 months, hours per week	2.4 (6.1)
Screen time at 12 months, hours per week	2.6 (6.4)
	Percent (frequency)
Sex, female	49.0 (326)
Race	
Black	69.7 (457)
White	15.2 (100)
Other race/more than one race	15.1 (99)
Ethnicity, Latino/a	9.4 (59)
Maternal Characteristics	***Mean (SD)***
Age, years	27.3 (5.8)
Pre-pregnancy body mass index, kg/m^2	29.9 (9.2)
	Percent (frequency)
Race	
Black	71.4 (472)
White	19.2 (127)
Other race/more than one race	9.4 (62)
Ethnicity, Latina	6.5 (43)
Education	
≤High school graduate	47.8 (317)
Some college, college graduate, or graduate degree	52.2 (346)
Marital status	
Married or living with partner	58.8 (272)
Never married, divorced, separated, other	41.2 (191)
Household Characteristics	***Mean (SD)***
Number of adults in the household	3.7 (2.9)
Number of children in the household	1.3 (1.6)
Household chaos score at 6 months	24.3 (6.4)
Household chaos score at 12 months	25.1 (6.7)

Infant Characteristics	***Mean (SD)***
	Percent (frequency)
Annual household income	
< $20,000	50.4 (233)
≥ $20,001	49.6 (229)

Table 2.

Adjusted[a] estimates and 95% confidence intervals (CI) in analysis examining household chaos and infant weight-for-length z-score (n=401)

	Estimate (CI)	p-value
	12-month weight-for-length z-score	
Chaos averaged at 6 and 12 months	0.02 (0.001, 0.04)	0.04
	9-month weight-for-length z-score	
Chaos at 6 months[b]	0.02 (0.002, 0.03)	0.03
	12-month weight-for-length z-score	
Chaos at 6 months[b]	0.01 (−0.002, 0.03)	0.09

[a] Adjusted for infant age, race, sex, birth weight for gestational age *Z*-score; maternal age, education, marital status, and pre-pregnancy body mass index; number of adults in the household, number of children in the household, and household income; and any breastfeeding duration.

[b] Repeated measures linear regression model with exchangeable correlation structure to account for correlation between infant weight-for-length at 9 and 12 months.