Published in final edited form as:

J Perinat Neonatal Nurs. 2016 ; 30(4): 349–358. doi:10.1097/JPN.0000000000000218.

Paternal and Maternal Testosterone in Parents of NICU Infants Transitioning Home

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Abstract

What was observed or investigated—Lower testosterone during the transition to new parenthood is considered beneficial to help parents better engage with their infants. No data currently exists studying salivary testosterone of parents with infants in neonatal intensive care units (NICU) during the transition to home. We examine testosterone levels for parents of very low birth weight (VLBW) infants, including links between salivary testosterone and infant factors (such as breastfeeding), psychosocial stress, and changes over time.

Subjects and methods—Testosterone salivary samples were assayed after self-collection by 86 parents (43 fathers, 43 mothers) with NICU infants at wakeup and bedtime prior to discharge and at three additional times at home. Self-reported survey measures, including psychosocial reports, were also collected at these times.

Results and conclusions—Using multilevel modeling approaches, we report significant associations between paternal testosterone by time and psychosocial adjustment, and between both paternal and maternal testosterone and infant feeding mode. ($p < 0.05$). Results were significant after accounting for covariates. Our study is the first to examine the time course of diurnal testosterone for parents of premature infants over the transition home; as such, we suggest further research into better understanding parental physiology in this vulnerable parent population.

Keywords

testosterone; parenting; breast feeding; NICU; VLBW

Fathers and mothers of very low birth weight infants (VLBW, birth weight<1500g) experience long and often medically-complicated hospitalizations in the Neonatal Intensive

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Financial Disclosure: None of the authors have any financial relationships relevant to this article to disclose.

Conflict of Interest: No authors have any conflicts of interest to disclose.

Care Unit (NICU) with their children, who represent 18% of all premature births¹ and 2% of all live births in the United States.² The high prevalence of VLBW infants, combined with a reported lack of parental preparation and increased parental stress for caring for these infants³ suggests that better understanding of the adjustment needs of these parents and their families may help support their ongoing health. In this study, we examine the diurnal patterns of paternal and maternal testosterone, a hormone associated with stress, parenthood, and long-term health, in a group of NICU parents transitioning home, with a focus on associations between testosterone and key issues of adjustment from NICU to home, psychosocial stressors, and breastfeeding.

Parents of NICU infants report high levels of psychosocial stress,⁴ with mothers reporting higher levels of stress compared to fathers.⁵ Testosterone, a reproductive steroid hormone produced by the Hypothalamic-Pituitary-Gonadal (HPG) axis, is reactive to stress,⁶ and linked to mental health outcomes such as depression⁷ and physical health outcomes such as cardiovascular health.⁸ Men naturally have higher levels than women, and levels have a diurnal rhythm for both genders, with peak levels in the morning and decreasing levels across the day.⁹ The steepness of the diurnal decline of testosterone across the day has been associated with factors such as psychosocial functioning,¹⁰ and romantic relationship status.¹¹ Testosterone decreases with age; however, health and lifestyle factors can accelerate this decline, including obesity and widowhood.¹² In men, testosterone is lower in pair-bonded,¹³ monogamous,¹⁴ married men,¹⁵ and fathers.¹⁶ Lowered testosterone in new fathers is considered evolutionary beneficial by allowing fathers to have a temporary focus on parenting over romantic intimacy.¹⁴ This paternal decline in testosterone begins during the prenatal period¹⁷ and continues over the course of their partner's pregnancy.¹⁸ Elevated testosterone has largely been negatively linked to fathering involvement;¹⁹ however, while fathers show elevated testosterone in response to infant cries, they show decreased testosterone when infant cries are accompanied by nurturing behaviors.²⁰ These findings are consistent with the Steroid/Peptide Theory of Social Bonds, a social neuroendocrinology theory in which nurturing behaviors or contexts decrease testosterone, while competitive, challenging, or threatening behaviors or environments increase testosterone; parenting behaviors can be nurturing or competitive depending on the context.²¹

Much less is known about possible effects of testosterone in new mothers compared to fathers; however, there may be similar links between testosterone and maternal factors and care provided to infants.^{22, 23} While all women produce testosterone, mothers' testosterone is lower compared to non-mothers,²⁴ and there is a further lowering of testosterone in the immediate postpartum.²⁵ There is mixed evidence for lower testosterone in pair-bonded women.²⁶ High maternal testosterone may be associated with reduced abilities to breastfeed,²⁷ although not all studies have found links between breastfeeding and testosterone. Limited studies also suggest a relationship between maternal testosterone reactivity and maternal behavior for premature infants during brief parent-infant interactions.²⁸ As a hormone with strong links to social bonds, including those involved in pair-bonding, intimacy, and nurturance, testosterone is a hormone well-suited to help understand the complex neuroendocrine responses of both parents of VLBW infants as they transition home.²¹

The present study examines how paternal and maternal morning and evening testosterone levels are associated with infant factors (such as breastfeeding and birth outcomes) and psychosocial stressors and buffers across the transition from NICU to home. Using postnatal paternal and maternal testosterone levels, our study is particularly focused on links between testosterone and self-reported perceived stress, parenting competence and breastfeeding during the transition in both parents. Better understanding of the physiological functioning of NICU fathers and mothers may help parents and practitioners meet the needs of premature infants and families.

METHODS

Study Design and Participants

This study is a prospective analysis of pilot data from an initial randomized controlled trial using a smartphone technology application designed to support parents of VLBW NICU infants transitioning home. With no sociodemographic or physiological differences as a function of randomization in the initial study, we have combined intervention and control parents for this secondary, pilot cohort study of biomarker patterns among parents with infants in the NICU transitioning back into the community.

Participants were ≥ 18 years old, English speaking, and caring for a living VLBW infant together. The study period was four-weeks total covering the final two NICU weeks, discharge, and two weeks at home. Recruitment began when the infant transitioned from an isolette into an open crib (~34 weeks). Parents were informed of the study by research staff not involved in infant care and, if eligible, consented, and baseline entry questionnaires completed. The study was approved by Northwestern University's Institutional Review Board and registered at clinicaltrials.gov (NCT01987180).

All parents independently completed measurement tools and data collection via self-report surveys at three time points: baseline (approximately 14 days prior to discharge, T-14), one day prior to discharge (T-1), and 14 days after discharge (T+14). Recruitment occurred January 2013–February 2014. Surveys were distributed in a study packet with a calendar specifying when each survey needed to be completed. Reminder emails were also sent out using standard procedures. Overall survey return rate was 70%.

Salivary Collection and Assay

In the NICU, participants were given salivary sampling kits and instructed on how to prepare the samples. Sample collection occurred on the day before discharge (T-1), and on subsequent days at home [day after discharge (T+1), five days post-discharge (T+5), and two weeks post-discharge (T+14)]. Parents self-collected saliva at wakeup, 30 minutes after wakeup, and bedtime by expelling saliva through straws into sterile 5 mL cryogenic vials. Morning and bedtime diaries were completed immediately after the respective collections. The diaries reported information on time of waking and other daily behaviors, such as nicotine use and medications. All completed diaries and salivary samples were mailed to Northwestern University, where they were immediately logged and frozen at -80 Celsius then shipped to ZRT Laboratories in Beaverton, Oregon for assay. Saliva was assayed for

testosterone using competitive luminescence immunoassay, with reported detection limits of 2.1–3,000 pg/mL. Inter-assay precision coefficient of variation at 16.3 pg/mL is 10.9% and at 529.0 pg/mL is 14.6%. The reference range of testosterone for men is 44 – 148 pg/mL and 16 – 55 pg/mL for women. Overall biomarker return rate was 76%.

Outcomes and Measures

Psychosocial measures—The three validated psychosocial measures were the 10-item Perceived Stress Scale (PSS),²⁹ the 17-item Parenting Sense of Competence Scale (PSOC),³⁰ measuring parenting satisfaction and parenting self-efficacy, and the 10-item Edinburgh Postnatal Depression Scale (EPDS).³¹ The PSS measured frequency of stressful thoughts and feelings with higher scores indicating higher stress levels. Higher scores on the PSOC indicate a greater sense of parenting self-efficacy and satisfaction. The EPDS measured depressive symptoms for both parents where higher scores indicated greater levels of depressive symptoms. The PSS, PSOC, and EPDS were administered at three time points: T–14, T–1 and T+14, with sums across all items.

Infant-related variables—Infant variables included gestational age (weeks), birth weight (grams), and gestational number (from singleton to triplet). Breastfeeding status was determined through self-reports in the morning diary in the salivary kit. Women could report either exclusive breastfeeding, both formula feeding and breastfeeding, or formula feeding only. A dichotomous variable was created representing any breastfeeding, compared to no breastfeeding. All infant-related variables were included in statistical models as presented in final results.

Socio-demographic covariates—A dichotomous variable for marital status (referent: not married) was included as a control in final models. Although initial models included the nominal/class variables race (referent: White) and insurance type (referent: public), and the continuous measure for parent age, these were dropped from final regression models due to non-significance. All socio-demographic variables are shown in Table 1 to display demographic variation in the sample.

Statistical Analyses

We used a three-level hierarchical linear growth model (**proc mixed** in SAS 9.4) with sample-level variables modeled at Level 1 (e.g. education level), day-level variables at Level 2 (e.g. psychosocial measures), and stable individual/couple-level variables at Level 3 (e.g. gestational age). As our primary objective was to examine differences in testosterone rhythms over time by gender, all models either examined testosterone separately by gender or used gender at L3 in the HLM modeling.

Multiple imputations were used to account for missing data using a monotone missingness imputation method. The imputations were conditioned on all of the independent variables used in the HLMs resulting in 5160 total observations among 20 imputation data sets. Less than one third of the data including the outcomes and covariates throughout the entire study were imputed; no discernable patterns were found that predicted whether data were missing.

Imputations were done in SAS 9.4 using **proc mi**, and the model estimates and 95% confidence limits were calculated using **proc mianalyze**.

For parsimony, additional variables tested in earlier models but dropped for non-significance without affecting the main results included relationship quality (measured using the revised Dyadic Adjustment Scale),³² infant gender, length of NICU stay, wake time, medication use, shift work, income, sleep quality, sleep length, employment, education, and nicotine use. We included both static and change variables for the psychosocial measures to examine whether the baseline or transitional change in psychosocial adjustment was linked to testosterone. Further, given that breastfeeding patterns may change over the transition from NICU to home, an interaction term was created to examine how breastfeeding over the transition home is related to testosterone.

RESULTS

Our sample included 86 parents (43 fathers, 43 mothers), with average ages of 34 for fathers and 33 for mothers (Table 1). Most parents were white, educated, and married, and had infants with an average gestational age of 30 weeks. Eight percent of the sample had extremely low birth weight (<1000 g) infants. Average testosterone levels at wakeup were 83 – 96 pg/mL for men, and 25 – 30 pg/mL for women. Bedtime values were 46 – 49 pg/mL for men, and 14 – 18 pg/mL for women, showing the normative diurnal decline over the day. As is biologically expected, values at all time points and time of day were significantly ($p < 0.0001$) higher for men than women.

Hierarchical linear modeling of testosterone for fathers (Table 2) and mothers (Table 3) over the transition home show that while no psychosocial measures were associated with maternal testosterone, for fathers, increases in PSOC scores over time ($p < 0.01$) were associated with lower wakeup testosterone, while increases in EPDS scores over time ($p < 0.01$) were associated with lower bedtime testosterone. Higher baseline EPDS scores over the transition home ($p < 0.05$) were also associated with lower paternal bedtime testosterone. Finally, fathers reporting higher PSS scores had marginally higher wakeup ($p < 0.10$) and bedtime testosterone ($p < 0.10$), perhaps a sign of anxiety or hyper-vigilance during a stressful experience.

Significant demographic and infant outcome findings show marriage ($p < 0.01$) and having an extremely low birth weight baby ($p < 0.01$) associated with lower paternal morning testosterone, while later gestational age ($p < 0.05$) is associated with lower paternal bedtime testosterone. For mothers, there is an association between having a singleton and higher bedtime testosterone ($p < 0.05$). Session (time of collection) effects were significant for paternal wake testosterone and for maternal testosterone; paternal morning testosterone decreased ($p < 0.05$) over the transition home, while for maternal testosterone, both wake ($p < 0.01$) and bedtime ($p < 0.05$), increased over the transition home.

Breastfeeding status was associated with both maternal and paternal testosterone levels over the transition home. Fathers with breastfeeding partners had lower morning testosterone ($p < 0.01$) compared to fathers with non-breastfeeding partners, while mothers who breastfed

had lower evening testosterone ($p<0.01$), compared to non-breastfeeding mothers. Further, there was a significant interaction between session and breastfeeding for paternal bedtime testosterone ($p<0.01$) and maternal wakeup ($p<0.01$) and bedtime ($p<0.05$) testosterone. These effects indicate that for fathers with breastfeeding partners, bedtime testosterone declines over the course of the study, while for breastfeeding mothers, wakeup testosterone decreases and bedtime testosterone increases over the transition from NICU to home. This shift over the transition home suggests a flatter diurnal decline for breastfeeding women compared to non-breastfeeding women.

Marginal means (from Tables 2, 3) for testosterone at wake and bedtime by breastfeeding (or partner breastfeeding) status over the transition home are presented in Figures 1 and 2. Figure 1 shows that paternal wakeup testosterone is significantly higher at all time points with a non-breastfeeding partner, while bedtime testosterone is significantly higher at all but baseline (T-1) for these fathers. In sum, having a breastfeeding partner is significantly associated with lower diurnal paternal testosterone for fathers who have left the NICU. The picture for maternal testosterone is similar to fathers: for breastfeeding mothers (Figure 2) wakeup testosterone is lowest at all but baseline (T-1), and bedtime testosterone is lowest at all time points for breastfeeding mothers. After controlling for covariates, there is a robust association between having a breastfeeding partner and lower paternal testosterone, and between breastfeeding and lower maternal testosterone.

DISCUSSION

This study is the first to examine testosterone levels for fathers and mothers of premature infants as they transition home from the NICU, finding hormonal differences by gender, over the transition home, by psychosocial measures, and by infant-related factors, particularly own (mothers) or partner (fathers) breastfeeding status. The transition from the NICU to home, including resultant impacts on parents, is an understudied area of research, and this study of parent physiology is uniquely positioned to shed light on the special circumstances for parents of caring for a VLBW infant over time.³³ This study may represent new directions for understanding what parents go through and how best to help NICU fathers, mothers, and families successfully adjust to home using physiologic data to understand patterns of change for parents. Given the links between testosterone and health, this focus on parental biomarkers may provide valuable information about what NICU parents are experiencing physiologically in ways that may be underreported using self-report measures of stress and health.

As a first study of fathers and testosterone during NICU transitions there are a number of key study findings. Bedtime paternal testosterone was negatively associated with depression symptoms in our study, a finding consistent with prior research not in the NICU.⁷ An association between increasing paternal parenting competence and decreasing wake testosterone also exists, supporting links between nurturing parenting behavior and lower father testosterone. The stressors experienced by fathers of post-NICU VLBW infants are multifaceted and nuanced, as seen by the opposite associations between stress and depressive symptoms with testosterone levels, and worthy of future study and appreciation as programs are designed to include fathers in the NICU. Over the transition home, paternal

testosterone decreased, suggesting that this is a time during which fathers may focus on parenting and “nesting” that may lower testosterone. Our results show links between having an extremely low birth weight baby and lower testosterone, supporting a connection between lower testosterone and family focused behaviors.¹⁵ Although clinically high or low testosterone levels are linked to poor health outcomes, our levels are within normal ranges, and could be temporarily lowered during a time for fathers of intense focus on the family and infants.

One particularly interesting finding is the associations between fathers and their breastfeeding partners. While this a novel and small study, for fathers in our study having a breastfeeding partner was associated with lower paternal testosterone in the morning and declining testosterone over the transition home suggesting that breastfeeding may be physiologically beneficial for fathers in so far as low testosterone is considered biologically adaptive for new fathers,¹⁶ and related to infant nurturing and pair bonding overall.²¹ We speculate that a plausible link between lower paternal testosterone and breastfeeding may exist for the following reasons: 1) lower testosterone is associated with increased father-infant involvement; 2) paternal support is linked to higher rates of continued breastfeeding; 3) breastfeeding is associated with reduced maternal stress and more optimal sleep patterns for both parents; and 4) couples often have correlated hormone levels. Further, fathers with NICU babies may feel reassurance that their breastfed babies are receiving ideal nutrition (and these babies are likely to receive the health benefits), so they may invest more with their NICU babies compared to fathers without breastfeeding partners, factors that may influence their physiological investment and potentially reduced stress (represented by lower testosterone) in their families. If these findings were replicated in further studies, they would suggest adaptive benefits of breastfeeding for fathers, in addition to the well known physiologic and health benefits for mothers and infants.

Among mothers, breastfeeding was also associated with lower bedtime testosterone. Although past literature has reported associations between maternal testosterone and psychosocial measures,³⁴ in our study, maternal testosterone was not associated with psychosocial factors. Our lack of findings may reflect the influence of breastfeeding in both reducing stress³⁵ and associations with lower testosterone.²⁷ Low testosterone in women has been linked to poor well-being and reduced libido in premenopausal women.³⁶ This prior study’s results may not, however, reflect the experiences of postpartum mothers of VLBW infants in our study, who are experiencing unmeasured hormonal changes of new parenthood, altered further by a months-long NICU course.

Over the transition home maternal testosterone increases which may represent a normalizing physiological response. Maternal bedtime testosterone is, however, also positively associated with having a presumably less stressful singleton infant compared to twin/triplets and negatively with breastfeeding. Breastfeeding mothers also experience lower morning testosterone but higher bedtime testosterone over the transition, a profile suggesting a “flattening” rhythm, one that has been linked to less optimal health and psychosocial outcomes in cortisol; however the meaning of this testosterone change is unknown and requires further empirical study.

Overall, the most robust findings from this study are the connections between breastfeeding and testosterone, which present unique new directions for understanding physiological health of NICU parents and how care for infants and families might be adjusted. Breastfeeding itself benefits new mothers by reducing stress,³⁵ biologically promoting maternal behavior,³⁷ and improving health outcomes.³⁸ NICU families, however, often experience breastfeeding as a significant challenge, leading to low rates even after hospital discharge.³⁹ Prior studies have shown that breastfeeding may be stressful upon leaving the hospital for NICU mothers, who report low rates of exclusive breastfeeding; only 20% of mothers ever successfully transitioned to at-breast nursing in one study.⁴⁰ Whether the physiological mechanisms involving testosterone synthesis and release differ between women who directly breastfeed or express milk is not well elucidated, nor explored within this pilot study. There are, however, a number of related hormonal fluctuations related to breastfeeding that are linked with testosterone release that may be at play.

While breastfeeding benefits are clear for infants and mothers, better understanding of the family-level factors and benefits associated with breastfeeding premature infants may improve health outcomes for these medically fragile children and their parents. Fathers' attitudes about breastfeeding are reported to influence breastfeeding rates and longevity,⁴¹ but left unknown is whether breastfeeding itself may benefit fathers. This study's findings that fathers benefit from lower testosterone if their babies breastfeed suggest that further research might explore possible biological influences of partner breastfeeding on men's health. Possible benefits for fathers may be indirect due to reduced maternal stress and healthier infants, or direct through health behaviors such as more optimal sleep patterns.⁴² Whether the lowered testosterone is long lasting or clinically significant is unknown, but supports links between low testosterone and parenting behavior. NICU infants are high-risk for a variety of poor health outcomes, and the associations between physiology and breastfeeding underscore the importance of supporting successful breastfeeding overall. Family-based approaches to care in the NICU where contextual support is offered to the entire family unit may hold the most promise for optimized outcomes.

Among the study's limitations is the fact that our sample was from a single NICU, with low diversity in terms of race, ethnicity, marital status, socioeconomic status, and father residency. Initiation and duration of breastfeeding for VLBW infants is strongly tied to socio-demographic factors,⁴³ and a more heterogeneous selection of participants is needed for external validity purposes. Data collection occurred at four time points so we are unable to track physiological patterns either before or after these time points. To that end, we cannot determine the causal direction between breastfeeding and testosterone; although high testosterone is causally tied to difficulty producing breast milk, breastfeeding is a natural stress reducer for women,³⁵ and could lead to reductions in testosterone. Although we requested that participants self-collect at specific time points across the day, we do not have objective measures of compliance with this protocol. Our study used a measure of breastfeeding that may be limited in scope and complexity. We acknowledge that infant feeding methods, particularly for VLBW infants, are varied and varying, including pumping milk and use of both milk and formula. Further, although poor or fragmented sleep is associated with lowered testosterone,⁴⁴ it may be the general measures of sleep included in this study may require more complexity to find a connection; it may be that the

breastfeeding households had increased nighttime feeding time, with more bottle cleaning for those using pumped milk, which may have contributed to lower testosterone levels for parents. Any future research examining links between hormones and breastfeeding in vulnerable NICU families should present a more complex measurement of breastfeeding; as a pilot study, our results are more descriptive rather than causal. Finally, we suggest qualitative study into how fathers perceive their breastfeeding preterm infants. It may be that fathers experience the breastfeeding relationship as a sign of wellness or health, and further research could examine the experiences of NICU fathers with breastfeeding and their interpretation for their own and their infant's health.

This study provides further evidence of breastfeeding benefits for mothers and some early evidence of breastfeeding benefits for fathers. There are a number of clinical implications based on these findings. First, clinicians can continue to provide strong support for breastfeeding in the NICU population that is developmentally appropriate for both infants and mothers. Second, clinicians can strive to better understand the motivations behind breastfeeding for both parents and help maintain the breastfeeding relationship as it moves from feeding a fragile to a healthy infant. In this way, clinicians can better address the interrelationships relevant to successful breastfeeding within the developing family unit. Finally, the associations between lower paternal testosterone and having a partner who breastfeeds may be the beginning of evidence that fathers also benefit in families with successful breastfeeding; therefore, supporting fathers who in turn can more effectively support mothers as well may benefit the entire family over time.

CONCLUSION

Paternal and maternal testosterone levels for parents of VLBW infants is tied to both parenting behaviors such as breastfeeding and the transition from the NICU into the home, while paternal testosterone changes are also linked to psychosocial adjustment. These findings have implications for better understanding paternal and maternal physiology for parents of VLBW infants and how best to support both parents as they transition home from the NICU. Future research into postnatal physiology that is inclusive of paternal and maternal pathways will help expand understanding and better support the needs of parents as they navigate caring for their VLBW infant.

Acknowledgments

Funding Source: All phases of this research were supported by grant #R21 HS20316 to CFG from the Agency for Health Research and Quality. This funding source had no involvement in the study design, collection, analysis, or interpretation of data, in writing of this report, or in the decision to submit the article for publication.

Abbreviations

NICU	neonatal intensive care unit
VLBW	very low birth weight

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Figure 1.
Paternal Testosterone Levels During the Transition from the NICU to Home

Figure 2.
Maternal Testosterone Levels During the Transition from the NICU to Home

Table 1

Descriptive Statistics for NICU-2-HOME Paired Couples (N=43)

Individual-Level Descriptive Statistics

Variable	Fathers (N=43)	Mothers (N=43)
	Mean (SD)	Mean (SD)
Parent Age	34.12 (5.9)	33.33 (6.10)
Race		
White	29 (67.4%)	27 (62.8%)
Black	6 (13.9%)	8 (18.6%)
Hispanic	4 (9.3%)	4 (9.3%)
Asian	2 (4.7%)	4 (9.3%)
Other	2 (4.7%)	0 (0%)
Education		
Some High School	0 (0%)	1 (2.3%)
High School Graduate	2 (4.7%)	2 (4.7%)
Some College	8 (18.6%)	5 (11.6%)
College Graduate	19 (44.2%)	18 (41.9%)
Advanced Degree	14 (32.6%)	17 (39.5%)
Psychosocial measures		
Baseline PSOC	68.77 (10.62)	72.84 (9.13)
Baseline PSS	15.90 (6.88)	17.26 (7.66)
Baseline EPDS	6.65 (4.23)	8.86 (4.32)
PSOC T ⁺¹⁴	74.79 (11.41)	72.02 (11.73)
PSS T ⁺¹⁴	14.86 (7.74)	15.70 (7.74)
EPDS T ⁺¹⁴	5.67 (4.31)	6.13 (3.87)

Individual-Level Testosterone Statistics

	Fathers (N=43)		Mothers (N=43)	
	Mean (SD)	Median (Range)	Mean (SD)	Median (Range)
Testosterone at Wake T ⁻¹	95.73 (36.77)	92 (16–181)	25.37 (18.30)	21 (6–84)
Testosterone at Bed T ⁻¹	46.55 (33.29)	39 (16–122)	13.59 (7.98)	13 (4–35)
Testosterone at Wake T ⁺¹	89.47 (28.82)	81.5 (39–176)	25.73 (19.04)	23 (6–84)
Testosterone at Bed T ⁺¹	46.30 (34.78)	38 (9–122)	18.39 (10.63)	15 (5–51)
Testosterone at Wake T ⁺⁵	83.46 (35.74)	78 (18–176)	25.11 (12.65)	22.5 (9–63)
Testosterone at Bed T ⁺⁵	47.06 (24.05)	43 (9–122)	18.17 (15.12)	13 (3–69)
Testosterone at Wake T ⁺¹⁴	91.74 (41.06)	86 (25–181)	30.14 (20.48)	23.5 (7–84)
Testosterone at Bed T ⁺¹⁴	48.61 (21.15)	48 (9–100)	15.43 (9.95)	21 (4–46)

Family-Level Descriptive Statistics

	Mean (%)
Married	39 (90.7)
Breastfeeding	28 (84.9)

Family-Level Descriptive Statistics

	Mean (%)
Private Insurance	38 (88.4)
Birthweight <1000g	8 (19.1)
Singleton	31 (72.1)
Multiparous	13 (31.2)
Gestational Age ^I	29.69 (2.62)

^I Average gestational age at birth

Table 2

Change in Testosterone for Fathers Transitioning from the NICU to Home (N=43)

Parameter	Testosterone Wake				Testosterone Bed			
	β	SE	95% CI	β	SE	95% CI	β	95% CI
Intercept	4.90**	0.54	3.85	5.95	0.70	3.84	6.59	
Session	-0.02*	0.01	-0.04	0.00	0.01	-0.02	0.03	
Married	-0.68**	0.11	-0.89	-0.47	0.08	-0.24	0.40	
Breastfeeding	-0.32**	0.12	-0.55	-0.09	0.06	-0.23	0.35	
Session * Breastfeeding	0.02	0.03	-0.04	0.08	-0.13**	-0.20	-0.05	
Private Insurance	0.02	0.04	-0.06	0.10	0.01	-0.23	0.26	
Intervention	0.03	0.10	-0.16	0.21	-0.15	-0.40	0.10	
Singleton	0.10	0.07	-0.04	0.23	0.10	-0.07	0.28	
ELBW <1000g	-0.29**	0.11	-0.51	-0.08	-0.27~	-0.54	0.01	
Gestational Age	0.01	0.02	-0.03	0.04	-0.05*	-0.10	0.00	
Multiparous	0.00	0.07	-0.13	0.12	0.07	-0.11	0.25	
PSS (T-1)	0.12~	0.07	-0.02	0.25	0.15~	-0.03	0.32	
PSOC (T-1)	-0.03	0.04	-0.11	0.05	-0.04	-0.15	0.06	
PSS (T-14-T+1)	-0.07~	0.04	-0.15	0.01	0.06	-0.05	0.16	
PSOC (T-14-T+1)	-0.13**	0.03	-0.20	-0.07	-0.04	-0.12	0.05	
EPDS (T-1)	-0.08	0.05	-0.18	0.03	-0.23**	-0.37	-0.09	
EPDS (T-14-T+1)	0.02	0.04	-0.06	0.10	-0.13*	-0.23	-0.02	

* p < 0.05,

**

p < 0.01,

~ p < 0.10

Note: ELBW = Extremely Low Birth Weight; PSS = Perceived Stress Scale; PSOC = Parenting Sense of Competence; EPDS = Edinburgh Postnatal Depression Scale

Table 3
Change in Testosterone for Mothers Transitioning from the NICU to Home (N=43)

Parameter	Testosterone Wake			Testosterone Bed		
	β	SE	95% CI	β	SE	95% CI
Intercept	1.41	0.97	-0.49 3.31	1.10	0.85	-0.55 2.76
Session	0.03**	0.01	0.01 0.05	0.05*	0.02	0.01 0.08
Married	0.07	0.24	-0.40 0.55	-0.15	0.21	-0.56 0.27
Breastfeeding	0.08	0.21	-0.33 0.50	-0.86**	0.21	-1.27 -0.45
Session* Breastfeeding	-0.13**	0.03	-0.19 -0.08	0.13*	0.05	0.02 0.23
Private Insurance	0.00	0.20	-0.39 0.39	0.00	0.16	-0.31 0.31
Intervention	-0.00	0.17	-0.33 0.33	-0.01	0.15	-0.29 0.28
Singleton	0.19	0.17	-0.14 0.52	0.33*	0.15	0.04 0.61
ELBW <1000g	0.06	0.22	-0.37 0.49	-0.21	0.19	-0.58 0.17
Gestational Age	0.05	0.03	-0.02 0.11	0.04	0.03	-0.01 0.10
Multiparous	0.01	0.16	-0.30 0.31	-0.26~	0.14	-0.53 0.01
PSS (T-1)	0.01	0.18	-0.34 0.35	0.07	0.16	-0.24 0.37
PSOC (T-1)	-0.07	0.08	-0.21 0.08	-0.01	0.07	-0.13 0.13
PSS (T-14-T+1)	0.00	0.10	-0.20 0.20	0.09	0.09	-0.09 0.26
PSOC (T-14-T+1)	-0.05	0.09	-0.23 0.13	0.03	0.08	-0.12 0.19
EPDS (T-1)	-0.10	0.18	-0.45 0.26	-0.14	0.16	-0.45 0.17
EPDS (T-14-T+1)	0.01	0.08	-0.15 0.17	-0.02	0.07	-0.16 0.13

* $p < 0.05$,

** $p < 0.01$,

~ $p < 0.10$

Note: ELBW = Extremely Low Birth Weight; PSS = Perceived Stress Scale; PSOC = Parenting Sense of Competence; EPDS = Edinburgh Postnatal Depression Scale