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# Short-term changes in fathers' hormones during father–child play: Impacts of paternal attitudes and experience

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ABSTRACT

Hormonal differences between fathers and non-fathers may reflect an effect of paternal care on hormones. However, few studies have evaluated the hormonal responses of fathers after interacting with their offspring. Here we report results of a 30-minute in-home experiment in which Filipino fathers played with their toddlers and consider whether paternal experience and men's perceptions of themselves as fathers affect hormonal changes. Fathers provided saliva and dried blood spot samples at baseline (B) and 30 (P30) and 60 (P60, saliva only) minutes after the interaction. We tested whether testosterone (T), cortisol (CORT), and prolactin (PRL) shifted after the intervention. In the total sample, T did not vary over the study period, while CORT declined from B to P30 and P60, and PRL also declined from B to P30. Fathers who spent more time in daily caregiving and men who thought their spouses evaluated them positively as parental caregivers experienced a larger decline in PRL (B to P30) compared to other fathers. First-time fathers also had larger declines in PRL compared to experienced fathers. Experienced fathers also showed a greater decline in CORT (B to P60) compared to first-time fathers. These results suggest that males' paternal experience and age of offspring affect hormonal responses to father–child play and that there is a psychobiological connection between men's perceptions of themselves as fathers and their hormonal responsivity to childcare.


## Introduction

Humans are relatively unique among mammals in that fathers frequently invest heavily in raising offspring and, particularly, provide direct care to children (Geary, 2000; Gray and Anderson, 2010; Kleiman and Malcolm, 1981). As a consequence, human fathers must manage time and energetic trade-offs between mating and parenting effort, as is true for other species in which paternal care is common (Clutton-Brock, 1991; Kleiman and Malcolm, 1981; Stearns, 1989; Trivers, 1972). Studies exploring the hormonal mechanisms underlying transitions between these conflicting components of reproductive strategy have focused in particular on the behavioral and physiological effects of testosterone (T) and prolactin (PRL), and, to a lesser degree, cortisol (CORT) (Wingfield et al., 1990; Wynne-Edwards, 2001).

T is an androgenic steroid produced by the hypothalamic–pituitary–gonadal (HPG) axis that modulates behaviors related to reproduction and conspecific interaction (Nieschlag and Behre, 2004). Because it is anabolic for skeletal muscle and promotes behaviors related to territoriality, dominance, libido, and courtship (Archer, 2006; Bribiescas, 2001; Hart, 1974), T is understood as facilitating males' mating effort, often at the expense of paternal investment (Gray and Campbell, 2009; Gray et al., 2002; Wingfield et al., 1990). Consistent with this expectation, numerous human studies have shown that fathers have lower T compared to single non-fathers (Gettler et al., 2011; Gray et al., 2006; Kuzawa et al., 2009; Muller et al., 2009).

Prolactin (PRL), a peptide hormone released from the anterior pituitary, is best known for its role in milk production during lactation and as a facilitator of maternal nurturing behavior (Freeman et al., 2000; Numan and Insel, 2003). In males, PRL has been shown to increase with paternal care in multiple avian and mammalian species (Ziegler, 2000), and, in non-human primate fathers, PRL appears to facilitate weight gain in anticipation of paternal care, thus helping buffer fathers from the energetic costs of parenting (Ziegler et al., 2009). In human males, there is evidence that PRL is implicated in paternal care, as fathers with higher baseline PRL have been shown to engage in more exploratory play with their children (Gordon et al., 2010b) and to be more responsive to infant cries (Fleming et al., 2002).

The glucocorticoid cortisol (CORT), which is primarily produced by the hypothalamic–pituitary–adrenal (HPA) axis, is also increasingly posited to be a regulator of some maternal behaviors and attachment (Wynne-Edwards, 2001; Ziegler, 2000), including in human

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mothers (Fleming et al., 1987, 1997). However, the role of CORT in human fathering is poorly characterized. Fathers with more lifetime experience caring for children have been found to have lower CORT (Fleming et al., 2002), while baseline CORT has been shown to be lower in partnered fathers compared to single non-fathers in the Philippines (Gettler et al., 2011). Expectant fathers' CORT appears to peak in the weeks before their partners' give birth, then falling off drastically post-partum (Berg and Wynne-Edwards, 2001; Storey et al., 2000). Thus, these existing studies suggest a potential role for CORT in human fathering, though the hormone's possible involvement with paternal care, emotions, and attachment are not well understood.

Much of the prior work on human paternal socioendocrinology has focused on single hormonal measurements, or averages collected across several days, which therefore identify relatively stable hormonal differences between fathers and non-fathers (Alvergne et al., 2009; Gettler et al., 2011; Gray, 2003; Gray et al., 2002, 2006; Kuzawa et al., 2009; Muller et al., 2009). Hormones are notable, however, for the speed with which they respond to changes in socio-behavioral context (van Anders and Watson, 2006), which has inspired a small but growing number of studies investigating acute hormonal responses to social stimuli, including to childcare. For example, while it is well known that oxytocin and PRL rise in mothers during breastfeeding (Heinrichs et al., 2001; McNeilly et al., 1983), recent studies have also shown that mothers who provide affectionate care to their children show oxytocin increases after interacting with them (Feldman et al., 2010) as do mothers who have secure adult attachments (Strathearn et al., 2009). It has likewise been demonstrated that maternal infant holding can induce short-term declines in mothers' CORT (Heinrichs et al., 2001), particularly during skin-to-skin care among new mothers (Mörelius et al., 2005).

Few similar studies have evaluated hormonal responses of human fathers to child interaction, but findings to date support a similarly acute responsiveness to infant cues or direct interaction, with the direction and magnitude of hormonal responsivity often depending upon a range of individual characteristics. For instance, studies report that a father's hormonal response to child interaction varies based on whether he lives with his children (Gray et al., 2007), whether he has spent time with his children on the day of sampling (Storey et al., 2011), whether he is a first-time father (Delahunty et al., 2007), and whether he plays with his child in a stimulatory manner (Feldman et al., 2010). Other studies suggest that a man's psychological disposition (e.g. aggressive vs. docile; dominant vs. passive) can influence acute hormonal responses to social stimuli (Suarez et al., 1998; van der Meij et al., 2008; Wirth and Schultheiss, 2006). However, to date, there has been little consideration of the psychobiological connections between hormonal reactivity and fathers' socio-emotional characteristics, such as attitudes about paternal roles and men's relationships with their spouses in terms of childcare duties, which may have implications for the ways in which they respond physiologically to contact with their children.

Here we sought to clarify hormonal responses of fathers to interacting with their child by examining T, PRL, and CORT before and after men (age $26.6 \pm 0.3$ [SD] years; $n = 42$) spent 15–30 min playing with one of their young children in their home. Our study drew on a sample of fathers residing in and around Cebu City (Philippines), where it is common for men to be involved in daily care of their children (ECD et al., unpublished data.; Gettler et al., 2011; Kuzawa et al., 2009). Based on prior human and non-human primate research, we hypothesized that T and CORT would significantly decline and PRL would significantly increase after the father–child interaction. We also tested whether fathers showed different patterns of hormonal change based upon: a) being a first-time father; b) being a father to an infant [1 year old or less]; and c) their self-reported daily caregiving involvement. Finally, we assessed how men's "caregiving identity" (how important it is for a father to be a caregiver to his child) and "perceived reflected-appraisals" (how a father perceives his partner's evaluation of him as a caregiver) (Maurer et al., 2001) affected hormonal responses to child interaction.

## Methods

### *Study population*

Data were collected in 2009 and 2010 as part of the Cebu Longitudinal Health and Nutrition Survey (CLHNS), a population-based birth cohort began in 1983–84. Men were a mean of age $26.6 \pm 0.3$ (SD) years at the time of data and sample collection in 2010. Socioeconomic, demographic, health and general behavioral data were collected using questionnaire-based, in-home interviews administered by Cebuano-speaking interviewers (Adair et al., 2011). Weight (kg) and height (cm), and triceps and suprailiac skinfold thicknesses (mm) were measured using standard anthropometric techniques. Percent body fat was calculated from triceps and suprailiac skinfold thicknesses using body density estimates and a body composition predictive formula (Durnin and Womersley, 1974; Lohman et al., 1988). The body mass index (BMI) was calculated as the ratio of weight (kg)/height ($m^2$). Self-reported psychosocial stress in the month preceding sampling was quantified via a modified version of the 10-item Perceived Stress Scale (PSS) (Cohen et al., 1983). Participants provided ratings of their self-perceived psychosocial stress on the day of sampling in response to the question "How stressful was your day today?" using a 5-point scale, ranging from "Not stressful at all" to "Very stressful." Men similarly rated their sleep quality, pertaining to the night before the interview, using a 5-point scale ranging from "I slept very poorly" to "I slept very well." This research was conducted under conditions of informed consent with human subjects' clearance from the Institutional Review Boards of the University of North Carolina, Chapel Hill and Northwestern University.

### *Sample characteristics*

During the 2009 survey, 908 males of the original cohort of 1633 liveborn males were located and interviewed. 451 of these men were fathers. In 2010, fathers were selected for the father–child interaction study based on living with at least one biological child, older than 1 year of age and less than 4 years of age, and the mother of that child, having no adopted or step-children, and having full data from the 2005 and 2009 CLHNS surveys. A sample of 164 met these criteria. Because of budgetary constraints and the size of the Cebu metropolitan area, sampling was restricted to 23 local barangays (neighborhoods), compared to 135 barangays in the 2009 survey, resulting in a final sample of 45 men who agreed to participate. Two subjects were excluded because of CORT values 6+ SD above the mean of the sample, while a second subject was excluded for having PRL that was 11 SD above the sample mean and having undetectable CORT. Unpaired t-tests were used to compare original cohort data (1983–1984) for the 42 men in this analysis and excluded individuals. Men in this sub-sample were born to slightly less educated mothers (average grade completed: 6th grade vs. 8th grade; $p < 0.05$), but did not differ from excluded individuals on household income, household size, birth order, mother's height, or birth length and weight (all $p > 0.2$). In comparisons between this sub-sample of men (2010) and the full sample of CLHNS men (2009), our substudy fathers were similar in height (162.6 vs. 162.9 cm) but had slightly greater BMI (mean: 23.7 vs. 22.7 kg/$m^2$; $p < 0.1$). They had also achieved a comparable level of education (mean: 10th grade). As of 2009, compared to other CLHNS married fathers, men in our sample had been married longer (mean: 4.8 vs. 3.8 years; $p < 0.01$) and had been fathers for a comparable duration (3.7 vs. 3.3 years; $p > 0.2$), with more children on average (2.2 vs. 1.6; $p < 0.0001$).