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Birth characteristics and developmental outcomes of infants of Mexican-origin adolescent mothers: Risk and promotive factors

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Abstract

Infants of adolescent mothers are at increased risk for negative developmental outcomes. Given the high rate of pregnancy among Mexican-origin adolescent females in the US, the present study examined health characteristics at birth and developmental functioning at 10 months of age in a sample of 205 infants of Mexican-origin adolescent mothers. Infants were relatively healthy at birth and had near average developmental functioning at 10 months. The educational attainment of adolescents and their mothers, and infants' temperamental regulation, promoted positive developmental functioning, while the combination of low adolescent parental self-efficacy and high infant temperamental negativity was associated with greater developmental delay. Findings are discussed with respect to implications for prevention with this at-risk population of mothers and infants.

Keywords

adolescent mothers; child temperament; infancy; risk factors

The United States has the highest rate of adolescent pregnancy among western industrialized nations (United Nations, 2007). Within the US, adolescent females of Mexican origin have the highest birth rate of all ethnic groups (National Vital Statistics Report, 2007). Because children of adolescent mothers tend to experience adverse health and developmental outcomes (e.g., Furstenberg, Brooks-Gunn, & Morgan, 1987), and these adverse outcomes become more pronounced with age (e.g., Whitman, Borkowski, Keogh, & Weed, 2001), there is a need to better understand the health and developmental outcomes of infants of Mexican-origin adolescent mothers and to identify early risk and protective factors that may moderate such outcomes. Given the lack of research on infants of Mexican-origin adolescent mothers, the first goal of the current study was to describe the birth characteristics of a sample of infants born to Mexican-origin adolescents, and our second goal was to describe their cognitive and social-emotional functioning at 10 months of age. In addition, because previous research indicates that dimensions of parenting such as maternal self-efficacy (East & Felice, 1996) may be important to children's developmental outcomes, and that children with more difficult temperaments are at higher risk for developmental delays (e.g., Halpern, Garcia Coll, Meyer, & Bendersky, 2001), our third goal was to test whether adolescent mothers' parenting efficacy was related to developmental outcomes at 10 months, and whether individual differences in negative temperament moderated these associations.

Birth characteristics of Mexican-origin infants born to teenage mothers

Mexican-origin adolescent females between the ages of 15 and 19 years show risks of preterm birth (13%) that slightly exceed the percentage of preterm births for infants in the US on average (12.7%) and the percentage of preterm births for infants of Mexican-origin adult mothers in the US (11.9%; National Vital Statistics Report, 2007). With respect to the proportion of infants born with low birthweight (i.e., less than 2500 grams), figures are 7.4% for Mexican-origin teen mothers (National Center for Health Statistics, 2010), 6.5% for all mothers of Mexican origin, and 8.2% for the overall US population (National Vital Statistics Report, 2007). While these data support what is frequently referred to as an “Epidemiologic Paradox” concerning newborns of Latino heritage, such that Latino mothers have infants with remarkably healthy birth outcomes despite their relatively low socioeconomic status and low rate of using prenatal care (Padilla, Boardman, Hummer, & Espitia, 2002), they also suggest an increased risk for Mexican-origin *adolescent* mothers relative to their adult counterparts. In this study, we describe the birth characteristics of infants of Mexican-origin adolescent mothers, and further, we extend this work by examining how key demographic factors (i.e., nativity, age, educational attainment, household income) are associated with variability in infant birth characteristics. Given prior evidence that the birth outcomes of infants of Mexican-American *immigrant* mothers are healthier than those of their US-born counterparts (Fuller et al., 2009; Padilla et al., 2002), we expected that infants born to Mexican-origin adolescent immigrant mothers may be less likely to be preterm or low birthweight than those born to US-born Mexican-origin adolescent mothers. Further, we also anticipated that household income and educational attainment would be negatively associated with pre-term status and low birthweight.

Describing social and cognitive developmental functioning at 10 months of age

The current state of knowledge concerning developmental outcomes for children of Mexican-origin adolescent mothers is limited, but available findings concerning the social and cognitive outcomes of infants of Mexican-origin mothers are less positive than those regarding infants' birth characteristics. Data from a large, nationally-representative sample of US children indicated that by 24 months, Mexican-origin toddlers scored significantly lower on measures of cognitive development and showed significantly slower growth in cognitive proficiency between 9 months and 24 months of age than did non-Latino White children (Fuller et al., 2009). Outcomes may be worse for young children of Mexican *adolescent* mothers, given the greater risk factors associated with the transition to parenthood during adolescence (Whitman et al., 2001). Thus, a second goal of the current study is to describe the social and cognitive developmental functioning at 10 months of age for children born to Mexican-origin adolescent mothers.

Although there is limited information on the developmental functioning of children of Mexican-origin adolescent mothers, and few recent large-scale studies of children of adolescent mothers in general, previous findings indicate that these children have poor developmental trajectories (Furstenberg et al., 1987). While such children appear to function within normal ranges on developmental assessments and on social-emotional measures (e.g., responsivity, activity, mood) in their first year of life, they begin to show signs of social-emotional difficulties by the end of their first year and a decline in other developmental trajectories thereafter (Borkowski et al., 2002; Furstenberg et al., 1987; Moore, Morrison, & Greene, 1997; Whitman et al., 2001). It is notable that children of adolescent mothers are at *three to four* times greater risk for developmental delays in intelligence, language, and social-emotional functioning than children of adult mothers (Black et al., 2002; Borkowski et al., 2004; Chandra et al., 2002; Furstenberg et al., 1987). The present study will extend the

current literature by describing the cognitive and social developmental functioning at 10 months of age in a sample of infants of Mexican-origin adolescent mothers, and identifying factors associated with their risk for delay. Because previous research has noted the importance of factors such as adolescents' maturity (e.g., age, educational attainment) and characteristics of adolescents' family of origin (e.g., nativity and parents' educational attainment) in informing adolescent mothers' parenting competence (Contreras, Narang, Ikhlas, & Teichman, 2002; Shapiro & Mangelsdorf, 1994), we will explore whether such factors predict infants' cognitive and social functioning.

Identifying risk and promotive factors in Mexican-origin infants' social and cognitive developmental functioning

In an effort to examine the mechanisms that inform infant outcomes, we draw on an ecological framework (Bronfenbrenner, 1989) and a risk and resilience perspective (Masten & Coatsworth, 1998; Rutter, 1987) to consider how individual infant characteristics and vulnerabilities may interact with adolescent mothers' characteristics to inform infants' developmental functioning and risk for delay. Specifically, our third goal is to test whether individual differences in adolescents' parenting efficacy relate to risk for delay at 10 months, and whether infant temperament moderates this association. An ecological framework emphasizes that human development is shaped in the context of children's interactions with their surrounding environments (Bronfenbrenner, 1989), and in this study we consider the role of the family context, with specific attention to characteristics of infants' mothers and characteristics of their families of origin. Further, a risk and resilience framework (Masten & Coatsworth, 1998; Rutter, 1987) directs our attention to the role of risk and promotive factors in our understanding of children's developmental outcomes. In this study, we consider infant temperamental negativity as a potential risk factor and temperamental orienting/regulation and maternal self-efficacy as potential promotive factors.

Considerable research has identified infant temperament as an important predictor of children's developmental functioning across multiple domains (Rothbart & Bates, 2006). In particular, children with "difficult" or "negative" temperaments, including low adaptability, high activity, and low regulation, tend to be at highest risk for cognitive delay (e.g., Halpern et al., 2001; Stright, Gallagher, & Kelly, 2008). It is thought that heightened negative emotions may compromise infants' informational processing and capacity to learn from their environment (e.g., Johnson, Posner, & Rothbart, 1991) and later affect children's development of higher order thinking, planning, and problem solving (Blair, 2002). In the present study, we expect infant temperamental negativity to be a risk factor associated with lower levels of cognitive performance and a greater number of developmental delays. Contrary to temperamental negativity, orienting/regulation is a dimension of temperament that tends to *promote* positive developmental outcomes in childhood. Infants with greater orienting/regulation (i.e., the ability to modulate reactivity), show greater effortful control later in infancy, along with higher prosocial behavior and lower impulsivity and conduct problems across childhood (Eisenberg et al., 2004; Valiente et al., 2006). As infants' orienting/regulation skills become more mature toward the end of the first year, we expect to see early evidence of individual differences in this temperamental dimension among infants in our study. Specifically, those infants with greater orienting/regulation are expected to demonstrate better performance on measures of developmental functioning.

Many studies have demonstrated that infant temperament, particularly negativity, may also moderate the effect of contextual factors (e.g., characteristics of the parent) on infants' developmental outcomes (Rothbart & Bates, 2006). Such work is consistent with Belsky's (2005) differential susceptibility hypothesis, which states that children may differ in the

degree to which aspects of their environment affect their development based on inherent characteristics (i.e., in their sensitivity to contextual influences). For example, a child's temperamental characteristics may leave the child more susceptible to *both* the negative effects of risky environments *and* the positive effects of supportive environments (Belsky, Bakermans-Kranenburg, & van Ijzendoorn, 2007; Ellis, Boyce, Belsky, Bakermans-Kranenburg, & van Ijzendoorn, 2011). Differential susceptibility theory is in contrast with theories that focus primarily on the disproportionate *negative* effects of adversity on certain individuals, such as the dual-risk model (Sameroff, 1983). Empirical support for the differential susceptibility model has emerged across various dimensions of parental functioning, including maternal synchrony and parental discipline (Feldman, Greenbaum, & Yirmiya, 1999; Kochanska, Aksan, & Joy, 2007). As discussed below, the unique circumstances of adolescent mothers make it particularly important to understand how their readiness to parent may interact with infant temperament to inform their young children's developmental outcomes (O'Callaghan, 2001).

There is increasing evidence of the importance of perceived parental efficacy in understanding adolescent mothers' readiness to parent. Parental self-efficacy, which refers to beliefs concerning one's abilities as a competent and effective parent (Bandura, 1989), has been significantly linked to parenting behaviors and, in turn, child outcomes (East & Felice, 1996). It is generally understood that satisfaction and confidence in one's role as a parent is connected to proficiency (Bohlin & Hagekull, 1987; Coleman & Karraker, 1997). Perceived efficacy has been found to be particularly important in situations involving ecological risk (Elder, 1995; Halpern, 1993). Mothers who report lower levels of parenting self-efficacy tend to be at greater risk for parenting stress (Reece & Harkless, 1998), which has consistently been linked to less positive parenting (e.g., Crnic, Gaze, & Hoffman, 2005). Indeed, there is much empirical evidence linking perceived parental efficacy with an array of positive parenting skills (Coleman & Karraker, 2000). Given the importance of considering parental efficacy in situations involving ecological risk, such as the context of adolescent parenthood, and our emphasis on child negative temperament as a potential risk factor in the prediction of children's developmental functioning, the third goal of this study was to explore the role of parental efficacy for promoting infants' developmental functioning, and to explore whether infants' negative temperament moderated this association. Specifically, we hypothesized that infants with high negativity whose mothers had low parental efficacy would show poor developmental outcomes, while those whose mothers had high parental efficacy would show relatively better developmental outcomes. Because much of the previous research on child temperament by parenting context interactions focuses on social-emotional and behavioral child outcomes, with few researchers predicting children's cognitive outcomes (e.g., Blair, 2002), our study will extend this research by predicting children's risk for developmental delay in an effort to provide insight into the mother–infant dyads that are at heightened risk for poor developmental trajectories and that should be the target of intervention.

Method

Participants

The current sample included 205 infants (58% male), their adolescent mothers, and adolescents' mother figures, who were part of an ongoing longitudinal study of Mexican-origin adolescent mothers, their mother figures, and their children, in a metropolitan area in the southwest. Adolescents were recruited during their third trimester of pregnancy, and were an average of 16.24 years of age ($SD = .99$; $Range = 15$ to 19) at Wave 1. The majority of adolescents were born in the United States (64.3%), and the remaining 35.3% were born outside the US. Slightly over half of the adolescents in the current study were enrolled in school (58.9%). Of those currently attending school, 55.8% were enrolled in a public school,

and the remainder were in charter, private, alternative, and home schools. On average, adolescents had completed 10.24 years of education ($SD = 1.38$). Mother figures reported a mean age of 40.83 years ($SD = 7.02$). The majority of mother figures (88%) were adolescents' biological mothers, with the remainder being other female family members, such as an aunt or the boyfriend's mother. On average, adolescents' mothers had completed 9.10 years of education ($SD = 3.43$) and adolescents' fathers had completed 8.81 years of education ($SD = 3.35$). At the first wave of data collection, adolescents had lived in the US for an average of 12.84 years ($SD = 5.13$), and the majority of adolescents (87%) co-resided with their mother figure. The average household income was \$27,487 ($SD = \$19,986$).

Procedure

Brochures were distributed at community centers and high schools serving the target population (see Umaña-Taylor, Updegraff, & Gonzalez-Backen (2011) for detailed information regarding recruitment). Research staff conducted screening calls with all adolescents who returned a contact card indicating interest in participating in the study ($n = 321$). We successfully contacted 95% of these adolescents, and 85% of those contacted were screened as eligible. Among eligible adolescents, 80% agreed to participate in the study. Demographic data were collected during a home interview conducted with the adolescent during her third trimester of pregnancy (i.e., Wave 1). Data on infants' birth characteristics were collected during a phone interview with the adolescent approximately two weeks after the estimated due date. Additional information concerning infants' health at birth, subsequent health and physical development, assessments of infants' developmental functioning, and adolescents' reports of infant temperament and parental efficacy were obtained at a second home visit (i.e., Wave 2) when infants were 10 months old ($M = 10.13$ months; $SD = .22$ months). At the 10-month home visit, a trained field interviewer facilitated mother-child assessments, conducted infant developmental assessments, and obtained measures of infants' physical development. The infant's portion of the home visit lasted 45 minutes, on average, and interviews with adolescents lasted an average of 2.5 hours.

Measures

All measures were translated into Spanish and translated back into English by two separate bilingual individuals. Discrepancies were resolved following guidelines described by Knight, Roosa, and Umaña-Taylor (2009).

Background characteristics—At Wave 1, adolescents' and mother figures' background characteristics were collected during a home interview. Adolescents were asked to report on their *age* at the time of the visit, their *educational attainment* (i.e., highest level of education completed), the country in which they were born (i.e., *nativity*), the *length of time living in the US* in years, and their *parents' educational attainment*. We also assessed adolescent-mother figure *coresidence* status by asking adolescents whether they lived with the mother figure. Finally, we assessed adolescents' *household income* by using self-report data from mother figures who coresided with adolescents. Household income was computed by creating a sum of: mother figures' annual income, funds received from any other individual who contributed to the household, and financial assistance from public assistance and/or food stamps.

Infant characteristics—Adolescents reported on their due date at the time of recruitment, and on infants' date of birth and birth characteristics (*gender*, *birthweight*, and *birth length*) in a phone interview conducted approximately two weeks after birth. *Gestational age* was calculated based on the difference between infants' due dates and actual birth dates, with due dates reflecting 40 weeks gestation. Infants' preterm status was characterized as *late*

preterm (i.e., 34 to 36 weeks gestation) or *early preterm* (i.e., less than 34 weeks gestation). Based on reported birth weight, infants were characterized as being *low birthweight* if they weighed less than 2500 grams (5 lbs, 8 oz), and *very low birthweight* if they weighed less than 1500 grams (3 lbs, 5 oz).

At the 10-month home visit, infants' *weight* and *height* were assessed by a trained field interviewer. Weight measurements were obtained using a Detecto Physician's Scale (Model 8440). After undressing the infant down to his or her diaper and laying or seating the infant on the scale tray, two measures of weight were taken and averaged to ensure accuracy. Height measurements were taken by laying the infant on a large white sheet of paper, ensuring that the infant's legs were straight and feet were together, and marking the paper at the infant's head and heel. The space between markings was subsequently measured and recorded in inches.

Infant developmental functioning—Standardized measures of infants' developmental functioning were administered at the 10-month home visit. The Bayley Scales of Infant Development—Second Edition (BSID-II) Mental Scale was used to assess infants' cognitive, language, and personal-social development, and the Bayley Behavior Rating Scale was used to measure observed behaviors during testing (Bayley, 1993). To assess inter-observer reliability, two trained observers overlapped coding on 15% of the sample and reliability was estimated using Intraclass Correlation Coefficients (ICC-alpha). The average ICC for ratings of experimenter observations was .93. The BSID-II is a widely-used measure that shows good internal consistency for infants aged 1 to 12 months (Cronbach's $\alpha = .83$) and high concurrent validity with other measures of children's developmental functioning (Bayley, 1993). In the present study, the standardized Bayley Mental Development Index (MDI) score derived from the Mental Scale was used as a measure of infants' developmental functioning, and the three subscales derived from the Behavior Rating Scale (i.e., *Orientation/Engagement*, *Motor Quality*, and *Emotion Regulation*) were used as measures of infants' observed behaviors. A Bayley Behavior Rating Scale Average variable (reflecting the mean score across the three subscales) was also created for use in main study analyses.

Infants' risk for developmental delay was assessed using the Denver Developmental Screening Test (Denver-II; Frankenburg et al., 1996), a measure of achievement of developmental milestones in the personal-social, gross motor, fine motor-adaptive, and language domains. From this measure, incorrect items were scored as *cautions* (i.e., failed items that more than 75% of same-age or younger infants in the standardization sample pass) or *delays* (i.e., failed items that more than 90% of same-age or younger infants in the standardization sample pass). In the present study, we consider the *total number of cautions and delays* (in combination) as an indicator of risk for developmental delay.

Infant temperament—Maternal reports of child temperament were measured using an abbreviated version of the Infant Behavior Questionnaire, Revised (IBQ-R; Gartstein & Rothbart, 2003). For the purposes of the present study, we utilized 131 items to derive the broad factors of *Negative Affectivity* (i.e., the composite of sub-scales for distress to limitations, smiling and laughter, sadness, and fear) and *Orienting/Regulation* (i.e., the composite of subscales for duration of orienting, soothability, falling reactivity, and approach). Adolescent mothers were asked to describe their children's behavior over the past week during times of sleep, bathing, dressing, play, and daily activities, as well as general behaviors, maternal soothing techniques, and child responses to soothing over the past two weeks. Items on each subscale were scored on a 7-point Likert-type scale from *never* to *always*. The measure has demonstrated adequate internal consistency for the broad factors of Negative Affectivity and Orienting/Regulation (Cronbach's α for both

factors = .91; Garstein & Rothbart, 2003). In the present study, Cronbach's alpha was .73 for Negative Affectivity and .76 for Orienting/Regulation.

Parental self-efficacy—Adolescents' perceived *parental self-efficacy* was assessed using the 25-item Postnatal Parental Expectations Survey (Reece, 1992; Reece & Harkless, 1998). This measure assesses the degree to which adolescents believe they are able to manage the tasks associated with being a parent (e.g., "I can manage the feeding of my baby"). Item responses were scored on a 5-point Likert scale, with endpoints of *not at all sure* (1) and *very sure* (5). The internal reliability was tested by the developer of the instrument and Cronbach's alpha was .97 (Reece & Harkless, 1998). In the present study, Cronbach's alpha was .93.

Results

Characteristics of infant health and physical development

Infants were born at an average of 38.63 weeks' gestation ($SD = 1.47$). Nineteen infants (9.3%) were considered preterm. Of these, the majority of infants ($n = 16$) were born late preterm, and only three infants were born early preterm. Newborns weighed an average of 7.11 pounds ($SD = 1.00$) and had an average length of 19.49 inches ($SD = 1.66$). A total of eight infants (3.9%) were considered to be low birthweight, and one infant was very low birthweight. Because birthweight was significantly associated with gestational age, $r(203) = .51$, $p < .001$, we controlled for gestational age in all subsequent correlation analyses that included birthweight.

Of those who reported on type of delivery (95% of the sample), the majority of adolescent mothers (85.6%) reported to have had a vaginal delivery, while 14.4% had a Cesarean section. Regarding infants' neonatal health status, 12.6% of adolescents reported that their infants went to the Neonatal Intensive Care Unit (NICU) either immediately following birth or at some point during the hospital stay post-delivery, and a small proportion of infants (6.8%) were reported to have had a birth defect, developmental delay, or medical condition when they were born. No significant gender differences were found in any of the infant birth characteristics.

At 10 months of age, infants had a mean weight of 20.37 lbs ($SD = 2.32$ lbs) and a mean height of 28.33 inches ($SD = 1.50$). Boys weighed significantly more ($M = 20.94$ lbs, $SD = 2.29$ lbs) than girls ($M = 19.54$ lbs, $SD = 2.13$), $t(179) = -4.17$, $p < .001$, Cohen's $d = .63$, and were significantly taller ($M = 28.53$ inches, $SD = 1.56$ inches) than girls ($M = 28.05$ inches, $SD = 1.37$ inches), $t(180) = -2.13$, $p < .05$, Cohen's $d = .32$. For these and all subsequent mean difference analyses, effect sizes (Cohen's d s) were calculated as Mean 1 – Mean 2/pooled SD (Cohen, 1988). A small effect is $d = .20$, a medium effect is $d = .50$, and a large effect is $d = .80$. When asked about specific medical problems between birth and 10 months, the percentage of adolescents who reported the following problems were: ear infections (35.4%), intestinal problems (38.5%), respiratory problems (66.2%), and high fevers over 103° (30.3%). The percentage of infants reported as having been hospitalized between birth and 10 months of age was 23.6%. The reasons given for hospitalization were gastroenteritis (15.6%), respiratory (35.6%), other infections/fever (22.2%), injury (2.2%), a congenital or neonatal complication (15.6%), and other reasons (8.9%).

Infant developmental functioning at 10 months of age

At the 10-month home visit, infants had a mean Bayley Mental Development Index (MDI) score of 93.29 ($SD = 7.15$). The majority of infants (89.5%) performed "Within Normal Limits," 9.4% were classified as having "Mildly Delayed Performance," and 1.1% of infants

demonstrated “Accelerated Performance.” While a majority of infants performed “Within Normal Limits,” as a group, infants in the current study performed below average (i.e., .43 standard deviations below the mean, or at the 33rd percentile) relative to the normative population (Bayley, 1993).

To examine hypothesized gender differences in Bayley MDI scores, one-tailed independent sample *t*-tests were conducted. Findings indicated that boys had significantly lower Bayley MDI scores ($M = 94.39$; $SD = 7.34$) than girls ($M = 92.53$; $SD = 6.95$), $t(180) = 1.74$, $p < .05$, Cohen’s $d = .26$.

On the Bayley Behavior Rating Scale, the majority of children (60.5%) scored “Within Normal Limits” on their Orientation-Engagement Behaviors, with 39.5% of infants scoring below the 25th percentile (23.7% “Questionable,” and 15.8% “Non-Optimal”). Only 1.7% of infants scored below the 25th percentile on their Emotion Regulation Behaviors (1.1% “Questionable,” 0.6% “Non-Optimal”), with the majority (98.3%) scoring “Within Normal Limits” on this scale. All children scored “Within Normal Limits” on the Motor Quality scale. No gender differences were found on any of the Behavior Rating Scale subscales.

With respect to delays on the Denver Developmental Screener, children displayed the most delays, overall, in the fine motor domain, followed by language, motor, and personal-social domains (see Table 1). In terms of cautions, the personal-social domain had the highest average, followed by fine motor, language, and gross motor domains. Data on delays and cautions were consistent with that from the Bayley MDI such that those children with higher Bayley MDI scores had significantly fewer cautions, $r(182) = -.35$, $p < .001$, and delays, $r(182) = -.24$, $p < .01$, on the Denver Developmental Screener. In terms of gender differences, one-tailed independent samples *t*-tests revealed that boys showed more delays in the personal-social and fine motor domains, more cautions in the fine motor domain, more total cautions across all domains, and more combined cautions and delays overall (see Table 1).

Prediction of infant birth and developmental characteristics by demographic background characteristics

Intercorrelations among demographic and study variables were tested to reduce the overall number of variables included in our main analyses. Data reduction was based on significant correlations among theoretically overlapping constructs. Because birthweight, height, and gestational age were highly positively correlated, we relied on birthweight (controlling for gestational age) as an index of birth characteristics. In terms of adolescents’ demographic characteristics, because adolescents’ nativity and years living in the US were highly correlated, nativity status was used in subsequent analyses. Finally, because adolescents’ mothers’ educational attainment, fathers’ educational attainment, and household income were highly positively related, we retained mothers’ educational attainment in subsequent analyses. Data reduction resulted in the following demographic variables: *adolescents’ age*, *adolescents’ educational attainment*, *adolescents’ nativity*, and *mothers’ educational attainment*. *Infant birthweight* (controlling for gestational age) was used in subsequent analyses to reflect birth characteristics, and the Bayley MDI, Denver Total Cautions and Delays, and Bayley Behavior Rating Scale Average were used to represent infants’ cognitive functioning, risk for delay, and observed behaviors, respectively. See Table 2 for correlations among these main study variables, their means, and standard deviations. Based on the recommendations of Curran, West, and Finch (1996), no variable had skewness or kurtosis values to indicate significant non-normality.

Multivariate regression analyses were conducted to test whether demographic characteristics predicted infant birth and developmental characteristics while controlling for other variables (see Table 3). With respect to infant birthweight, older adolescent age and nativity (US-born status) emerged as significant predictors of higher infant birthweight. With respect to infant developmental outcomes, adolescent educational attainment and nativity (foreign-born status) emerged as promotive factors for infants' Bayley MDI. Additionally, higher adolescent age and lower adolescent educational attainment were associated with greater Total Cautions and Delays on the Denver Screener. Finally, adolescents' mothers' educational attainment emerged as a promotive factor for positive infant behavioral ratings on the Bayley Behavior Rating Scale (see Table 3).

Associations among infant temperament, developmental delay, and parental efficacy

As a preliminary step, we tested for, and found no significant gender differences in, either infant temperament or adolescents' reports of parental efficacy. We also examined the bivariate correlations among infant temperament, developmental delay, and parental efficacy. Consistent with our hypotheses, infants with greater temperamental orienting/regulation on the IBQ had fewer Total Cautions and Delays on the Denver Screener, $r(176) = -.18, p < .05$, and scored higher in the Bayley Behavior Rating Scale Average, $r(177) = .22, p < .01$. Adolescents who reported higher parental efficacy tended to have infants with greater temperamental orienting/regulation ($r = .39, p < .01$), and higher Bayley Behavior Rating Scale Average scores ($r = .20, p < .05$).

To address our third goal (i.e., whether infant temperament moderated the relation between parental efficacy and developmental delays and cautions), a hierarchical regression was conducted using centered variables and controlling for infant gender. Step 1 included parental efficacy, the moderator (infant negative temperament), and gender as the covariate. At Step 2, the product term of these centered variables was entered to test for the hypothesized interaction. Follow-up analyses were conducted for significant interactions, simple slopes were graphed one standard deviation above and below the mean of the moderator, and the independent variable was kept continuous (Cohen, Cohen, West, & Aiken, 2003). Findings revealed a significant temperamental negativity–parental efficacy interaction, $\beta = -1.77, t(173) = -2.37, p < .05$, in predicting delays and cautions, $F(4,173) = 2.489, p < .05, R^2 = .05$. Examination of simple slopes indicated that, consistent with our hypothesis, the greatest number of total delays and cautions emerged in dyads in which mothers reported relatively low parental efficacy and infants had relatively higher negative temperaments ($b = -.69, p < .05$, one-tailed), as compared to those dyads in which the infant had low negative temperament ($b = .53, ns$). See Figure 1.

As a follow-up to these analyses, we examined whether our findings supported Belsky's differential susceptibility hypothesis using the steps outlined by Belsky et al. (2007). The first step was achieved by obtaining the abovementioned statistically-significant interaction between the moderator (temperament) and the predictor (parental efficacy). Next, we confirmed that there was not a significant association between the moderator and the predictor, $r(191) = -.06, p > .05$, nor between the moderator and the outcome (Denver Total Cautions and Delays), $r(191) = .09, p > .05$. As a next step, we confirmed that the graphical display of the interaction had a cross-over design consistent with differential susceptibility, as per Belsky et al. (2007). Although the regression line for high negative temperament had a significant slope (at 1 SD above the mean) and was steeper than that for low negative temperament, the results indicate only modest support for differential susceptibility as the regression lines are in opposite directions and could also be indicative of a contrastive effect (Belsky et al., 2007). Finally, we tested the specificity of the model by replacing the

susceptibility factor with temperamental orienting/regulation and by replacing the outcome variable with Bayley MDI and Bayley Behavior Rating Scale Average, and found no significant interactions in these models.

Discussion

In an effort to better understand the developmental outcomes of young children of Mexican-origin adolescent mothers and to identify early risk and protective factors that may moderate such outcomes, the present study examined children's birth characteristics and 10-month cognitive and social-emotional functioning. Findings revealed that infants were relatively healthy at birth and had age-appropriate developmental functioning at 10 months. The educational attainment of adolescents and their mothers, and adolescent nativity emerged as important predictors to birth and developmental characteristics. In addition, findings concerning infant temperamental characteristics and adolescent mothers' perceived parental self-efficacy revealed that low adolescent parental self-efficacy and high infant temperamental negativity was associated with greater developmental delay.

Infant birth characteristics and developmental functioning

Findings on the birth characteristics of infants in the present study indicate that, in general, they were born healthy and with few complications. The majority of infants in our study were born full term, and few were born low birthweight. Our findings are consistent with previous research on the birth characteristics of infants of adolescent mothers from minority populations (East & Felice, 1996; Whitman et al., 2001). For example, the Notre Dame Parenting Project, which includes a majority African American adolescent mother sample, had a largely healthy sample of newborns with few who were born low birthweight or preterm (Whitman et al., 2001). Similarly, findings from the UCSD Teen OB Follow-Up study, which includes a diverse population of predominantly Hispanic and African American adolescent mothers, indicate full-term pregnancies, on average, and few low birthweight newborns (East & Felice, 1996). The fact that data from our study, and those of previous studies of adolescent mothers, are slightly better than those reported on Mexican 15 to 19 year-olds in the US as whole (National Center for Health Statistics, 2010), could reflect some degree of selection bias, with research volunteers being somewhat more health conscious, and perhaps more likely to receive prenatal care (East & Felice, 1996) than the general population. Overall, our findings reveal that the initial health status of infants in our sample is positive and that these infants do not begin life with considerable health disadvantages.

Data on infants' physical development at 10 months indicated that, on average, our sample looked equivalent to same-age infants from which national norms for growth (i.e., height and weight by gender) were based. With respect to hospitalizations, the predominant reasons for hospitalization reported in our study were consistent with those found in previous work (i.e., respiratory or other infections and gastroenteritis), indicating that our infants do not differ from other samples with respect to the types of illnesses for which they are at risk. However, in the present study, the rate of infant hospitalization prior to 10 months of age was notably elevated, not only compared to infants of adult mothers, but also in comparison to those from young or adolescent mother samples. While there is some evidence that children under the age of one born to adolescent mothers are at increased risk of hospitalization (e.g., Guevara, Young, & Mueller, 2001), the rate of hospitalization of infants in our study was approximately double the figures for infants from nationally-representative datasets with young mothers aged 14 to 25 (Strobino, Ensminger, Nanda, & Kim, 1992) and those from other large-scale studies of teenage mothers (Guevara et al., 2001). These findings highlight a potential early indicator of compromised health status

among infants in our sample, and may inform health practitioners and early interventionists to emphasize preventative health measures for this population. It is noteworthy, however, that the more positive statistics are drawn from epidemiological data gathered 10 and 20 years ago and may not be representative of the current health status of infants nationally.

Turning to other descriptive indicators, demographic characteristics emerged as significant predictors of infants' health, offering a better understanding of individual differences among this population. Adolescent mothers' age significantly predicted infants' birth-weights, indicating that aspects of mothers' biological and psychological maturity may relate to their own health behaviors during pregnancy that contribute to infants' birthweights. For example, East and Felice (1996) found younger adolescent age to be related to delayed prenatal care and less maternal weight gain during pregnancy. Interestingly, in the present study, infant neonatal health was also positively related to nativity, such that infants of US-born mothers had higher birthweights. Thus, somewhat contrary to our expectations and to research indicating an epidemiological paradox with respect to positive health outcomes for the infants of immigrant Latino mothers (Padilla et al., 2002), infants of US-born adolescents had higher birthweights in our study. It may be that the factors contributing to adolescents' pregnancy outcomes are different than those of adult mothers from which much of the research on the immigrant health paradox is based. For example, while Latina immigrant women in the US generally have healthy babies despite poor rates of prenatal care, it may be that there are added risk factors associated with adolescent pregnancy, such as risky behaviors or poor nutrition, for which living in the US for a greater time could buffer. Moreover, those adolescents who have lived in the US longer may be more aware of, and able to navigate, the US healthcare system as well as various agencies that would provide them with important resources during and after their pregnancy.

Studies of cognitive and behavioral outcomes for infants of adolescent mothers reveal that, although these children appear to function within normal ranges on developmental assessments and on social-emotion measures in their first year, they begin to show signs of social-emotional difficulties by the end of the first year and a decline in other developmental trajectories thereafter (Borkowski et al., 2002; Furstenberg et al., 1987; Moore et al., 1997; Whitman et al., 2001). Although findings on infants' 10-month developmental functioning from the present study are generally consistent with past work, they also indicate specific areas of potential developmental risk during the infants' first year, and offer insight regarding potential demographic protective factors associated with infants' functioning. The majority of infants in our sample performed within normal limits on the Bayley MDI, but the average performance of infants in our sample was below the normative population average on the Bayley MDI, suggesting a possible early indication of a downward trajectory in their developmental functioning. With respect to experimenter ratings of infant behavior, it is notable that the greatest variability in outcomes was seen in Orientation/Engagement behaviors, with almost 40% of infants in our sample scoring below the 25th percentile on this scale. This measure reflects the infants' interest, enthusiasm, initiative, and sustained attention in the testing situation (Bayley, 1993), which is thought to have important consequences for children's general exploration, manipulation, and ability to learn from their environments. Furthermore, orientation and engagement behaviors show important relations to both concurrent and later IQ (Black, Hess, & Berenson-Howard, 2000; DiLalla et al., 1990), highlighting the potential importance of these skills for future developmental outcomes. Thus, what remains to be seen in future work is whether their trajectories begin to show the decline that has been seen in other samples of infants of adolescent mothers, and also whether some infants, for example those scoring particularly low in orientation/engagement at 10 months, are at greater risk of such decline.

Infant boys in our sample performed significantly worse than girls with respect to their Bayley MDI scores, and their risk of delay on the Denver Developmental Screener, particularly with respect to personal-social and fine motor domains. These findings are consistent with the limited previous literature suggesting that infant girls may outperform boys in the verbal domain (e.g., Blakemore, Berenbaum, & Liben, 2009; Halpern, 1992; Hindmarsh, O'Callaghan, Mohay, & Rogers, 2000), which is assessed as part of the Bayley MDI. Thus, these findings may point to a somewhat greater risk among the infant boys of adolescent mothers. It will be important to see whether boys' developmental trajectories differ from those of the girls in our sample over time.

With respect to demographic factors related to infants' developmental functioning, not only adolescents' educational attainment, but that of their mothers emerged as promotive of infants' developmental outcomes. Adolescents' educational attainment was a significant positive predictor of the Bayley MDI and negatively related to Total Cautions and Delays on the Denver Screener. Adolescents' own mothers' educational attainment was also positively related to infants' Behavioral Rating Scale Average. These results are consistent with those of Whitman et al. (2001), who found that adolescent mothers' highest achieved education prior to childbirth predicted children's later IQ, but they also extend prior work by identifying maternal grandmothers' educational attainment as an important correlate of infants' behavioral outcomes. Assuming greater education is related to the intellectual development and knowledge base of adolescent mothers, the results support the notion that adolescent mothers' cognitive preparedness to parent is a key component of their children's outcomes. Furthermore, given the unique circumstances of adolescent mothers, our findings highlight the importance of considering the cognitive readiness of the adolescent mother's own parents or others who may affect children's outcomes either by directly facilitating infants' intellectual skills through interaction, or by way of indirect support and resources they provide the adolescent about her infant's development.

Risk and promotive factors associated with infant outcomes

In line with a risk and resilience framework for the study of human development (Masten & Coatsworth, 1998; Rutter, 1987), which seeks to identify factors associated with either positive or negative developmental outcomes, the final goal of our study was to explore the role of infant and maternal characteristics as risk or promotive factors for infants' developmental functioning. Specifically, we explored whether infant temperament was related to children's development and found that, as expected, temperamental orienting/regulation appeared as a promotive factor. This dimension of temperament was negatively related to Total Delays and Cautions on the Denver Developmental Screener, and positively related to experimenter ratings on the Bayley Behavior Rating Scale Average. Together, these findings are consistent with those of previous research suggesting that children who exhibit greater orienting/regulation, or the capacity to regulate their negative emotions, may be better able to learn from their environment (e.g., Johnson et al., 1991) and to develop higher order thinking, planning, and problem solving skills (Blair, 2002), whereas children with more difficult or negative temperaments are at risk for cognitive delay (e.g., Halpern et al., 2001; Stright et al., 2008).

Importantly, our study also identified an aspect of adolescents' readiness to parent, parental self-efficacy, to be related to infant outcomes and temperament. Specifically, infants who scored higher on the Bayley Behavior Rating Scale had mothers who indicated greater self-efficacy with their parenting ability. Additionally, adolescents' parental efficacy was positively related to infants' temperamental orienting/regulation. These findings underscore the importance of the adolescent's beliefs concerning her abilities as a competent and effective parent for her child's outcomes. Moreover, because previous work has noted that

parental stress relates to parents' feelings of efficacy (Nakagawa, Teti, & Lamb, 1992), it is possible that mothers whose infants exhibited the most temperamental orienting/regulation experienced higher parental efficacy and, one might speculate, less parental stress. These findings suggest that infant and maternal characteristics may work together to predict the developmental outcomes of children of adolescent mothers. Indeed, the results of our moderation analyses revealed a significant interaction between child and maternal characteristics in predicting child outcomes such that the combination of low adolescent mother parental efficacy and high infant temperamental negativity was associated with the greatest number of delays and cautions on the Denver Developmental Screener. Our results support Belsky's (2005) argument that the negative influence of some aspects of the parental context (i.e., low parental efficacy) may affect infants differently based on their own inherent characteristics (i.e., high negative temperament). Given that the slope for the highly negative infants was steeper than that for infants with low negativity, these results offer some support for the differential susceptibility hypothesis, indicating that highly negative infants are more sensitive to both the negative impact of low parental efficacy and the positive impact of high parental efficacy. However, given that the slopes for high and low negativity were also in opposite directions, the results could also be suggestive of a contrastive effect, indicating that the nature of the influence of parental efficacy on developmental delay differs for infants with high and low levels of negativity. These findings are informative for adolescent parenting interventions, particularly in light of research indicating that a high percentage of adolescent mothers tend to rate their children as difficult during infancy (Whitman et al., 2001). It may be that the highly stressful context in which they are parenting may impact adolescent mothers' perceptions of their infants' behaviors as being more negative, and these perceptions may negatively impact their parenting behaviors. Indeed, studies of non-adolescent samples have found that mothers with negative personality attributes (e.g., less positive mood, less flexibility) and those who perceive their infants as having more difficult temperaments report higher levels of parenting stress and have infants with lower Bayley MDI scores (Molfese et al., 2010). Thus, our study makes an important contribution to our knowledge about how these processes work together among the current sample of Mexican-origin adolescent mothers and highlight the dyads who may be at heightened risk for particularly poor developmental trajectories.

Limitations and future directions

The present study offers an important first step toward understanding the outcomes of infants of Mexican-origin adolescents. Given the high prevalence of teenage pregnancy in this population, and the lack of substantial data to date focusing on the outcomes of these young women and their children (Contreras, 2004), our findings contribute to our knowledge of risk and promotive factors that may inform infants' developmental outcomes. Our findings are limited, however, in that they include infant outcomes at a single point in time (i.e., when children are 10 months old) and do not allow for the exploration of factors contributing to developmental changes in infants' skills. Because cognitive and behavioral outcomes for children of adolescent mothers tend to worsen with age (e.g., Whitman et al., 2001), there is a particular need for future longitudinal work with this population that examines trajectories beyond infancy and provides information about optimal periods for intervention. Further longitudinal work on this population would also allow for the examination of important outcomes that become relevant after children's first year, including behavior problems and social-emotional skills. In addition, our study provides insights into a specific population of Mexican-origin adolescent mothers (i.e., those between 15 and 18 years of age living in a southwest metropolitan area) recruited through school and community agencies. Understanding the risk and protective factors for Mexican-origin adolescent mothers in different socio-cultural contexts (e.g., rural areas, established versus

new immigrant contexts) with differential access to resources (e.g., prenatal care, preventative infant care) in the US will be important. Finally, our study is also limited with respect to our measurement of adolescent parenting. While we focused on the salient dimension of parental self-efficacy, which was found to be both directly associated with infants' outcomes and in combination with negative infant temperament, there are a number of indices of parental competence that should be considered in future work, including adolescents' knowledge about child development and their overall psychosocial functioning.

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Figure 1. Interaction between Infants' Negative Temperament and Adolescent Mothers' Parental Efficacy in predicting number of delays and cautions scored on the Denver Developmental Screener. Simple slopes were graphed one standard deviation above and below the mean of the moderator. *Significant slope at $p < .05$.

Table 1

Cautions and delays by domains and gender on the Denver Developmental Screener

Denver Developmental Screener Domain or Scale Composite	Total sample		Males		Females		Gender differences
	M	SD	M	SD	M	SD	
Personal-social cautions	.65	.49	.69	.49	.61	.49	$t(180) = -1.05, p = .30$ Cohen's $d = .16$
Personal-social delays	.10	.32	.06	.25	.15	.40	$t(180) = 1.62, p = .11$ Cohen's $d = .28$
Fine motor cautions	.12	.35	.16	.41	.05	.23	$t(180) = -2.16, p = .03$ Cohen's $d = .32$
Fine motor delays	.44	.66	.58	.73	.23	.48	$t(180) = -3.95, p < .001$ Cohen's $d = .55$
Language cautions	.05	.27	.06	.31	.04	.20	$t(180) = -.59, p = .56$ Cohen's $d = .07$
Language delays	.32	.65	.31	.57	.34	.75	$t(180) = .24, p = .81$ Cohen's $d = .05$
Gross motor cautions	.01	.11	.01	.10	.01	.11	$t(180) = .27, p = .79$ Cohen's $d = .00$
Gross motor delays	.27	.64	.27	.71	.28	.54	$t(180) = .16, p = .88$ Cohen's $d = .02$
Total cautions	.84	.69	.92	.79	.72	.51	$t(180) = -1.93, p = .05$ Cohen's $d = .29$
Total delays	1.14	1.22	1.23	1.23	1.0	1.21	$t(180) = -1.26, p = .21$ Cohen's $d = .19$

Table 2

Correlations of study variables

	1	2	3	4	5	6	7	8	9	10	M	SD
1. Adolescent age	—										16.24	.99
2. Adolescent educational attainment	.53***	—									10.24	1.38
3. Nativity ¹	.01	.15*	—								—	—
4. Mothers' educational attainment	.02	.17*	.24**	—							9.10	3.43
5. Birthweight ²	.19**	.10	.18*	.04	—						7.11	1.00
6. Bayley MDI	.08	.15 [†]	-.17*	.06	.10	—					93.29	7.15
7. Denver Total Cautions & Delays	-.00	-.27**	.04	-.12	.01	-.35**	—				1.97	1.51
8. Bayley Average Behavior Rating Scale	-.07	.10	.13 [†]	.23**	-.06	.23**	-.28**	—			42.33	3.31
9. Parental efficacy	.02	.21**	.21**	.23**	.02	-.05	-.02	.20**	—		4.50	.42
10. Temperamental negativity	-.12	-.08	-.01	-.01	-.07	-.02	.09	-.11	-.06	—	1.45	.63
11. Temperamental orientation/regulation	-.05	.14 [†]	.03	.17*	-.06	-.02	-.18*	.22**	.39**	-.14 [†]	4.83	.61

¹ 0 = Foreign born, 1 = born in the US;² Controlling for gestational age.[†] $p < .10$;* $p < .05$;** $p < .01$;*** $p < .001$.

Table 3

Regression models with demographic characteristics predicting infant birth and developmental characteristics ($N = 205$)

Dependent variable: Infant birthweight			
Model $F(5, 189) = 18.12, p < .001; R^2 = .32$	β	B	SE
Gestational age	.53***	.36	.04
Adolescent age	.20**	.20	.07
Adolescent educational attainment	-.05	-.04	.05
Nativity ^I	.15*	.31	.13
Mother educational attainment	-.001	.00	.02
Dependent variable: Bayley MDI			
Model $F(4, 169) = 2.81, p < .05; R^2 = .06$	β	B	SE
Adolescent age	-.04	-.31	.67
Adolescent educational attainment	.18*	1.01	.51
Nativity ^I	-.21**	-3.20	1.20
Mother educational attainment	.08	.17	.16
Dependent variable: Denver Total Cautions and Delays			
Model $F(4, 169) = 5.27, p < .01; R^2 = .11$	β	B	SE
Adolescent age	.20*	.30	.13
Adolescent educational attainment	-.38***	-.43	.10
Nativity ^I	.09	.28	.24
Mother educational attainment	-.12	-.05	.03
Dependent variable: Bayley Average Behavior Rating Scale			
Model $F(4, 164) = 3.59, p < .01; R^2 = .08$	β	B	SE
Adolescent age	-.18 [†]	-.60	.31
Adolescent educational attainment	.18 [†]	.47	.24
Nativity ^I	.04	.25	.56
Mother educational attainment	.21**	.20	.08

Note.

^I 0 = Foreign born, 1 = born in the US.

[†] $p < .10$;

* $p < .05$; $p < .01$;

*** $p < .001$.