Health Psychology
2000, Vol. 19, No. 6, 544-553

0278-6133/00/$5.00 DOI: 10.1037//0278-6133.19.6.544

The Impact of Prenatal Maternal Stress and Optimistic Disposition on Birth Outcomes in Medically High-Risk Women

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A sizable body of evidence indicates that prenatal maternal stress (PNMS) has an adverse impact on birth outcomes, including birth weight and gestational age at delivery. The authors hypothesized that effects of PNMS are attributable in part to dispositions such as pessimism that lead women to view their lives as stressful and that effects of PNMS and disposition on birth outcome are mediated by prenatal health behaviors. Using structural equations modeling procedures, the authors examined prospective impact of PNMS and dispositional optimism on birth weight and gestational age in a medically high-risk sample (N = 129), controlling for effects of risk and ethnicity. After its strong inverse association with optimism was accounted for, PNMS had no impact on birth outcomes. Women who were least optimistic delivered infants who weighed significantly less, controlling for gestational age. Optimists were more likely to exercise, and exercise was associated with lower risk of preterm delivery. Results suggest that chronic stress in pregnancy may be a reflection of underlying dispositions that contribute to adverse birth outcomes.

Key words: pregnancy, stress, disposition, optimism, birth weight, health behavior

Infants weighing between 1,500 and 2,499 g at birth are five times more likely to die in the first year of life than normal-weight (2,500+ g) infants; those weighing less than 1,500 g are 65 times more likely to die (National Center for Health Statistics [NCHS], 1997). Surviving children have higher rates of subnormal growth and illness, and the majority exhibit mild deficits in cognition, attention, and neuromotor function (Hack, Klein, & Taylor, 1995; Newnham, 1998; Thompson et al., 1997). For example, children aged 6 to 15 years who were low birth weight are nearly 50% more likely to be in a special education program (Chaikind & Corman, 1991). Infants weigh too little at birth because of impaired growth in utero, because they were born too soon, or both. Preterm delivery (before 37 weeks of pregnancy) is itself associated with a range of severe health and developmental consequences (e.g., Ee, Hagan, Evans, & French, 1998). Rates of low birth weight, which range from 6.6% for non-Hispanic Whites in the United States to 13.2% for non-Hispanic Blacks (NCHS, 2000), have increased steadily since 1984; rates of preterm delivery in the United States are also on the increase (Paneth, 1995; NCHS, 2000).

A convergence of evidence indicates that prenatal maternal stress (PNMS) is an important contributor to adverse birth outcomes. Both animal and human studies find that mothers exposed to stress prenatally deliver infants significantly earlier and infants who weigh less at birth (e.g., Copper et al., 1996; Hedegaard, Henriksen, Secher, Hatch, & Sabroe, 1996; Lobel, Dunkel-Schetter, & Scrimshaw, 1992; Molfese et al., 1987; Wadhwa, Sandman, Porto, Dunkel-Schetter, & Garite, 1993; see reviews by Hoffman & Hatch, 1996; Lederman, 1995; Lobel, 1994; Paarlberg, Vingerhoets, Passchier, Dekker, & Van Geijn, 1995). An important theme emerging from this literature is that episodic or acute stress may not be as deleterious as chronic stress (Dunkel-Schetter & Lobel, 1998; Dunkel-Schetter, Gurung, Lobel, & Wadhwa, in press; Lobel, 1998). This theme has been most apparent in studies using multivariate approaches to conceptualize and operationalize PNMS. In these, stress is assessed by indicators of stress stimuli or stressors (such as major life events) over the course of pregnancy, repeated measures of stress perception or appraisal, and repeated measures of stress responses, particularly emotions such as anxiety. Such approaches provide strong tests of PNMS effects because

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This research was supported in part by National Institutes of Health (NIH) Biomedical Research Support Grant SO7RRO767-25. Marci Lobel and Carla DeVincent received support from NIH Grant 5R29NR03443 during preparation of this article. We are grateful to Valerie Parisi, Robert Barbieri, Judith A. Stein, Martin Stone, Joan Quigley, Marianne Tinkla, the staff of the Stony Brook Pregnancy Project, and all of the women who participated in this study.

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they are based on well-elaborated theories of stress and reliable measurement (Lobel, 1994; Lobel & Dunkel-Schetter, 1990).

Two possibilities might account for the chronicity of stress in these studies. The first is that environmental conditions that produce stress may not change during the 9-month period of a woman's pregnancy. A second possibility is that chronic stress may be a reflection of a woman's stable disposition or her tendency to experience her life as stressful. Disposition is likely to affect a pregnant woman's appraisals of stressful life conditions and her emotional experience of stress. We were interested in separating the impact of individual disposition from PNMS to determine the unique effect of "environmental" and "person" factors on birth outcome. In most previous research, these factors have not been separable. One exception is a recent study of pregnant women that demonstrated the independence of a latent construct composed of three dispositional variables and a second latent construct representing stress (Rini, Dunkel-Schetter, Sandman, & Wadhwa, 1999). After controlling for the strong negative association between these two latent factors, the dispositional construct predicted birth weight, and the stress construct predicted earlier delivery. However, stress in this study was operationally defined solely by global and pregnancy-specific state anxiety, neglecting other indicators of stress, including stressful stimuli or stress appraisal. Furthermore, the 2-week time frame in which anxiety was measured (28–30 weeks of pregnancy) provides a very limited assessment of the 40-week gestational period. For these reasons, additional evidence is needed to test the notion that environmentally produced stress and disposition exert unique effects on birth outcome.

Little research has been conducted on the impact of dispositional factors in pregnant women. Some studies examined trait anxiety, a stable predisposition to respond to situations anxiously, but produced equivocal results (Lobel, 1994). We examined dispositional optimism in the present study. Optimists have positive expectations for the future. They expect to do well and anticipate favorable outcomes. Pessimists[1] hold negative expectations and expect things to go poorly (Carver & Scheier, 1991; Scheier & Carver, 1985). In the face of threatening events, optimists experience less distress (Carver & Gaines, 1987; Carver et al., 1993; Scheier & Carver, 1992; Scheier, Weintraub, & Carver, 1986; Stanton & Snider, 1993), and they tend to appraise life conditions more favorably (cf. Cantor & Norem, 1989). Optimistic and pessimistic individuals also attend to, process, and retain information about health threats differently (Aspinwall & Brunhart, 1996). Women in the present study were at high risk for an adverse birth outcome because of chronic or previous medical conditions or because they were experiencing complications with the present pregnancy (for explanation of medical risk, see Hobel, 1982; Molfese, 1989; Wall, 1988).

Limited evidence exists regarding the effects of dispositional optimism on physical health. Dispositional optimists recover more quickly (Scheier et al., 1989) and more successfully (Fitzgerald, Tennen, Affleck, & Pransky, 1993) from coronary artery bypass surgery. Optimists have also been shown to exhibit better immune response to short-term stressors (F. Cohen et al., 1999). Furthermore, situational (as opposed to dispositional) optimism is associated with better immune response (Segerstrom, Taylor, Kemeny, & Fahey, 1998) and with better symptomatology profiles and survival in AIDS patients (Reed, Kemeny, Taylor, & Visscher, 1999; Reed, Kemeny, Taylor, Wang, & Visscher, 1994).

Several mechanisms may account for the impact of PNMS or dispositional optimism on birth outcome: changes in biochemistry, especially in the neuroendocrine and immune systems (see Dunkel-Schetter et al., in press; McEwen, 1998), and changes in behavior. We focused on the latter as an exploratory component of the present study. Early delivery and low birth weight are affected by smoking, alcohol abuse, and illicit drug use (Chomitz, Cheung, & Lieberman, 1995; McCormick et al., 1990), behaviors that optimistic pregnant women are likely to avoid but that may be increased under stress (Picone, Allen, Schramm, & Olsen, 1982). Optimists tend to engage in positive health practices, such as exercising, and they avoid health-impairing activities (Scheier & Carver, 1992). Similarly, stress has been shown to affect health-relevant behaviors that may mediate its adverse impact on birth outcomes (Griffin, Friend, Eitel, & Lobel, 1993; Krantz, Grunberg, & Baum, 1985), including smoking and substance use (Bresnahan, Zuckerman, & Cabral, 1992; Conway, Vickers, Ward, & Rahe, 1981; Hutchins & DiPietro, 1997), eating and sleeping patterns (Krantz et al., 1985), and compliance with therapeutic regimens (Caldwell et al., 1983). Thus, we examined relevant prenatal health practices to explore whether they would help explain the impact of optimism or PNMS on birth outcome.

Medical risk is also an important predictor of birth outcome, especially gestational age at delivery. Past research showed that medical risk should be accounted for when investigating the impact of psychological factors on birth outcome, because it can be confounded with their effects (Lobel, 1994). Although as a group women in the present study were at high risk for an adverse birth outcome, interindividual variation permitted us to examine the impact of medical risk in this sample.

Non-White ethnicity is an additional predictor of lower birth weight in the United States (NCHS, 1997, 2000; Rowley et al., 1993; Shiono, Klebanoff, Graubard, Berendes, & Rhoads, 1986), although even among White women rates of low birth weight are higher than in other industrialized countries (NCHS, 1997). For the current study, ethnicity was examined as a dichotomous variable, consisting of White and non-White ethnicity. Although this is a crude categorization, it was necessitated by the limited number of non-White women in the present study.

In summary, using structural equation modeling procedures, we examine the impact of optimism and PNMS on birth weight and gestational age at delivery while accounting for the impact of medical risk and ethnicity. We hypothesize that the impact of PNMS will be relatively lower than in past studies because the predicted inverse association between optimism and stress is controlled, and that optimism will exert independent impact on birth outcomes, especially birth weight (cf., Rini et al., 1999). In addition, we explore whether prenatal health behaviors will mediate effects of optimism or PNMS on birth weight and gestational age.

[1] We use the term "pessimist" throughout this article to refer to an individual low in optimism, consistent with the view that optimism and pessimism are poles of a unidimensional construct (Scheier & Carver, 1985; for opposing views see Marshall, Wortman, Kusulas, Hervig, & Vickers, 1992; Mroczek, Spiro, Aldwin, Ozer, & Bossé, 1993).

Method

Participants

The sample consisted of 129 women receiving prenatal care in a private, university-affiliated obstetric practice that caters to medically high-risk pregnancy. All were participants in a larger longitudinal study of prenatal stress and coping. To participate, women were required to be at least 18 years of age, because the research was not designed to deal with medical and psychosocial issues unique to adolescent pregnancy (Coley & Chase-Lindale, 1998). Participants were also required to be between 10 and 20 weeks gestation at first approach, after pretesting revealed that women experienced the physical and emotional implications of being pregnant at approximately 10 weeks into their pregnancies.

Study participants were at high risk for adverse birth outcomes because of chronic medical conditions (e.g., hypertension or diabetes), previous medical, gynecological, or obstetric problems (e.g., fetal demise) or because they were experiencing complications (e.g., bleeding or preeclampsia) with their current pregnancy (Hobel, 1982, 1990; Molfese, 1989). On average, women had two factors that put them at risk (SD = 1.5).

Participants ranged in age from 20 to 43 years (M = 31 years, SD = 4.6) and most (87%) were White. Virtually all (99%) were high school graduates; 33% completed college, and approximately 17% obtained graduate degrees. On average, women were 14.5 weeks pregnant (SD = 2.7) at study entry. Most (97%) of the sample was married or living with the infant's father as if married. Forty-six percent of participants reported an annual household income above $50,000 ($M$ = $35,000–50,000). Approximately half (49%) maintained full-time jobs during their pregnancies, 16% were employed part time, and 35% were not employed. Approximately 50% of study participants were giving birth for the first time.

Procedure

Eligible women were approached while waiting for their prenatal care appointment, given a brief description of the study, and asked to provide written informed consent. Participants completed a questionnaire at three time points during the course of their pregnancies: between 10 and 20 weeks gestation (Time 1), between 21 and 30 weeks gestation (Time 2), and after 31 weeks gestation (Time 3).

Of the 327 women approached, 279 (85%) agreed to participate. A total of 181 were administered at least one questionnaire; of these, 52 women had substantial missing data (they typically completed only a small portion of the first questionnaire) and were removed from the sample. Of the final sample of 129 participants, 14 women had an average of 1.6 missing items of 229 total study items. Mean substitution was used to replace their missing items because the extent of missing data was minimal. No differences were found between the 52 excluded participants and the women who comprised the study sample on any variables that we were able to examine, with one exception: Approximately 50% of the women excluded were non-White compared with 13% in the study sample ($p < .05$).

Measures

PNMS was measured using five indicators: an aggregate of repeated measures of perceived stress, a similar aggregate of repeated measures of state anxiety, pregnancy-specific distress, number of prenatal life events, and life event distress. Perceived stress and state anxiety were measured at all three time points, pregnancy-specific distress was measured at Time 2, and number of life events and life event distress were retrospectively reported at Time 3.

Perceived stress. The 10-item version of the Perceived Stress Scale (PSS; S. Cohen, Kamarck, & Mermelstein, 1983; S. Cohen & Williamson, 1988) was used to assess appraisals of general or nonspecific distress. Women reported, for example, how often they felt unable to control important things and how often they felt they could not overcome difficulties. At Time 1, participants responded for the time period since becoming pregnant; at Times 2 and 3, they responded for the period since their last questionnaire. Each item was rated on a 5-point scale ranging from 0 (*never*) to 4 (*very often*). Four items were reverse scored, and the 10 ratings were summed. The PSS had high internal consistency at Time 1 (α = .89), Time 2 (α = .86), and Time 3 (α = .90). As indicated by autocorrelations and repeated measures analysis of variance (ANOVA), perceived stress was highly stable throughout pregnancy. Therefore, PSS scores were averaged across the three time points to create a single prenatal perceived stress index for each participant (cf. Lobel & Dunkel-Schetter, 1990; Lobel et al., 1992).

State anxiety. Using a 4-point scale ranging from 1 (*not at all*) to 4 (*very much*), participants rated 20 items (e.g., "I feel nervous," "I am worried," and "I feel calm" [reverse scored] "right now . . . at this moment") on the State form of the State–Trait Anxiety Inventory (Spielberger, 1983). Internal consistency was very high at all three time points (each α = .95). State anxiety scores were stable across the three time points according to their autocorrelations and the results of repeated measures ANOVA; these were averaged to create a single prenatal state anxiety score for each woman.

Pregnancy-specific distress. Pregnancy-related distress was measured using the Prenatal Distress Questionnaire, a 12-item scale developed to assess the most common concerns of pregnant women (Yali & Lobel, 1999). Sample items include "Body changes bother me," "I worry about having an unhealthy baby," and "Physical symptoms of pregnancy such as nausea, vomiting, swollen feet, or backaches irritate me." Items were rated on a 5-point scale ranging from 0 (*not at all*) to 4 (*extremely*), and responses were summed. Internal consistency was high (α = .81).

Prenatal life events. The measure of stressful life events was adapted from prior research in pregnancy (Lobel et al., 1992). Participants recorded the occurrence of 27 life events that they, a close friend, or a family member experienced during the pregnancy (e.g., moving, getting married, being robbed, being involved in a serious car accident, or having someone close die). For each event endorsed, participants reported how undesirable or negative the event was on a 4-point scale ranging from 1 (*not at all*) to 4 (*very much*). Two indexes were created: number of life events during pregnancy and a mean life event distress score. The latter was computed by summing distress ratings and dividing by the total number of life events reported. Mean distress was used rather than a distress sum so that this variable would be independent of the number of events experienced. Study participants reporting no events were assigned an event distress score of 0.

Optimism. Dispositional optimism was measured at Time 2 using the Life Orientation Test (LOT; Scheier & Carver, 1985). Participants rate items such as "I always look on the bright side of things," "I always expect the best," and "I hardly ever expect things to go my way" (reverse scored) on a 5-point scale ranging from 0 (*strongly disagree*) to 4 (*strongly agree*). Four of the 12 items are filler questions and are not scored. The internal consistency of the optimism scale was high (α = .86), corroborating prior studies using this instrument.

Health behaviors. Based on a review of pertinent literature and consultation with a team of obstetric researchers and clinicians, a 27-item measure was developed (see DeLuca & Lobel, 1995). It assesses a broad range of relevant health behaviors, including substance use, smoking, nutrition, and exercise. This measure was administered at all three time points. Participants read statements such as "In the last 2 weeks, I tried to eat a balanced diet, including fruits and vegetables" and responded with one of the following choices: 1 (*never*), 2 (*almost never*), 3 (*sometimes*), 4 (*fairly often*), 5 (*very often*), or 6 (*always*).

Frequency of cigarette smoking, other substance use, exercise, and nutritional practices were of greatest interest in this study because of their documented impact on birth weight and gestational age at birth (e.g., Chomitz et al., 1995; Dewey & McCrory, 1994; Hall & Kaufmann, 1987; McCormick et al., 1990). Frequency of cigarette smoking was assessed with a single item. For the remaining categories of health behaviors, factor

analyses and internal consistency coefficients were examined to create scales at each time point. These analyses indicated that a reliable index of substance use could not be constructed from the three items assessing use of alcohol, marijuana, and other illicit substances (αs = .26, −.04, and .44, at each time point, respectively). Because there was uniformly low endorsement of these three items at each time point (means ranged from 1 to 1.1 on the 6-point scale), substance use was not included in further analyses.

Two items assessing frequency of stretching and of 15-min periods of exercise were summed to create an exercise scale with high internal consistency (αs = .78, .80, and .85 at each time point, respectively). Five items assessing frequency of nutritional practices were summed to create a nutrition scale: calcium and fluid consumption, minimization of fats, adherence to a balanced diet, and skipping meals (reverse scored). Internal consistency was acceptable for a scale of this type (αs = .64, .62, .61, respectively).

Repeated measures ANOVAs revealed no differences in smoking, exercise, or nutrition scores across the three time points. Therefore, scores were averaged over time to create a prenatal smoking, nutrition, and exercise score for each study participant.

Ethnicity. A dichotomous variable was created with values of White (n = 112) and non-White (n = 17). The non-White category included all participants who identified themselves as Black, Latino or Hispanic, Asian or Pacific Islander, or multiple non-White ethnicity.

Medical risk. Trained research assistants abstracted medical charts. A 38-item medical risk index was used to assign risk scores. This index was adapted from the Problem Oriented Perinatal Risk Assessment System (Hobel, Youkeles, & Forsythe, 1979). Items were grouped under the following six categories: unusual features of pregnancy (e.g., Rh negative), gynecological and obstetrical history (e.g., previous preterm delivery), complications of past pregnancies (e.g., hemorrhage), family history (e.g., diabetes), patient's medical history (e.g., hypertension), and current pregnancy complaints (e.g., anemia). Items were scored as present or absent and summed to create a risk score.[2]

Birth outcomes. Birth weight (in grams) and gestational age at time of delivery (in weeks) were obtained from medical charts and used as continuous variables in analyses.

Data Analytic Strategy

Data were first examined for violations of assumptions of univariate normality. Square root transformation was performed on number of life events, life event distress, state anxiety, pregnancy distress, and birth weight to reduce kurtosis.

A stepwise approach is recommended to test structural equation models (Anderson & Gerbing, 1988; Newcomb, 1990). The measurement model is tested by confirmatory factor analysis of latent variables; next, the structural model of associations among independent and dependent variables is tested. Accordingly, data analyses using the EQS program (Bentler, 1989) were undertaken as follows. First, we tested the measurement model of stress using all five hypothesized indicators of the latent stress factor. Second, we tested the measurement model of optimism using four subsets of randomly paired LOT items as indicators of this latent factor (see Newcomb, 1990; Marshall & Lang, 1990). Third, we tested the hypothesized structural model of gestational age and birth weight. In this model, stress, optimism, and medical risk were predictors of birth weight and gestational age. To control for its impact as demonstrated by past studies, ethnicity was included in the model as a predictor of birth weight. We also incorporated paths representing correlations of stress with medical risk and with optimism (inversely). Although optimism is a stable trait that is unlikely to be influenced by stress (e.g., Bromberger & Matthews, 1996; Scheier & Carver, 1985), we used a bidirectional path to represent the association between these variables, because we cannot rule out the possibility that chronic stress affected optimism in this study.

Table 1
Description of Major Study Variables

Variable	$M \pm SD$
Prenatal life events	2.4 ± 2.5
Life event distress	1.9 ± 1.4
Prenatal perceived stress	15.3 ± 5.5
Prenatal state anxiety	35.1 ± 10.5
Pregnancy-specific distress	14.8 ± 7.6
Optimism	20.4 ± 4.7
Smoking	1.4 ± 1.0
Exercise	2.3 ± 1.1
Nutrition	4.7 ± 0.6
Medical risk (no. of conditions)	2.1 ± 1.5
Birth weight (g)[a]	3,260 ± 518.5
Gestational age (weeks)[b]	38.5 ± 1.9

[a] 8% of sample <2,500 g. [b] 12% of sample <37 weeks.

In the final step of model testing, we examined the structural model, including health behaviors as mediators of the impact of stress and optimism on birth outcomes. Only those health behaviors that correlated with stress or optimism and also with at least one birth outcome were examined (cf. Baron & Kenny, 1986).

To avoid theoretically unguided "model fitting" (MacCallum, Roznowski, & Necowitz, 1992), a priori criteria were established for modifying the structural equation models. For the measurement models of stress and optimism, we used Wald tests (Bentler, 1989) to identify nonsignificant paths. The path whose removal increased the chi square by the smallest magnitude was dropped first, and the model was reexamined. This procedure was repeated until all paths in the model were significant. At this point, if the measurement model fit acceptably well according to the comparative fit index (CFI), which is a more reliable index of fit than the chi square in samples of this size (Bentler, 1990), then no further modifications were made. However, if the CFI indicated that the model was a poor fit, we used the results of Lagrange multiplier tests (Bentler, 1989) to add statistically significant associations among indicators of the latent factor. These were added one at a time, reevaluating the model after each modification. We adopted a more conservative approach for the structural models. After removal of nonsignificant paths using the procedures described previously, no further modifications were made.

Generalized least squares was the estimation method used; it performs better than other methods in samples of this size (Hu, Bentler, & Kano, 1992; Tabachnik & Fidell, 1996).

Results

Sample Description

Means and standard deviations for study variables are provided in Table 1. Although optimism was not used as a measured variable in the structural equation models, for purposes of sample description, the eight items of the LOT were summed (after appropriate reverse scoring). Comparisons with the results of other studies that administered the LOT to pregnant women (Carver & Gaines, 1987; Park, Moore, Turner, & Adler, 1997) suggest that participants in the present study were relatively less optimistic. Similar comparisons to previous research suggest that women in the present study experienced slightly more perceived stress than other pregnant (Lobel & Dunkel-Schetter, 1990) and nonpregnant

[2] The medical risk instrument is available from Marci Lobel.

(Cohen & Williamson, 1988) women, and that their level of state anxiety is similar to that of other pregnant (Lobel & Dunkel-Schetter, 1990) and nonpregnant (Spielberger, 1983) women. Rates of low birth weight and preterm delivery were slightly higher than national norms (NCHS, 1997) but consistent with the profile of a high-risk sample.

As shown in Table 2, age, education, income, and marital status were associated with some study variables. These correlations were of modest magnitude, and all suggested sensible relationships between variables. As expected, there were strong correlations among the psychological stress variables.

Model Testing

Measurement model of stress. In the first step of model testing, we examined the hypothesized measurement model of stress. The model was a poor fit, $\chi^2(5, N = 129) = 43.66, p < .001$, CFI = 0.55. The results of Wald tests indicated that the model could not be improved by removing paths. However, Lagrange multiplier tests suggested adding paths between the residual of life events and two other variables: life event distress and state anxiety. This means that these pairs of variables have common variance beyond that which defines the latent stress factor. After adding these two paths, the resultant model yielded $\chi^2(3, N = 129) = 1.42, p = .70$, CFI = 1.0, indicating that it was a good fit to the data. All of the paths were significant. Perceived stress, state anxiety, and pregnancy-specific distress loaded most highly on the latent factor.

Measurement model of optimism. In the second step, the measurement model of optimism was tested. All factor loadings for this model were significant, $\chi^2(2, N = 129) = 6.21, p < .05$, CFI = 0.91. Although the chi square indicated the model could be further improved, the CFI was high, indicating good model fit.

Structural model of gestational age and birth weight. In the next stage of analysis, the model of gestational age and birth weight was examined, incorporating all hypothesized relationships among study variables. In accordance with the procedures described previously, a number of paths were dropped based on the results of Wald tests. The paths representing impact of stress and medical risk on birth weight were dropped, as was the path representing the correlation between stress and medical risk. Furthermore, stress and optimism were not significant predictors of gestational age, so each of these paths was dropped.

Impact of health behaviors. In the final step of model testing, effects of health behaviors were explored. Of the three health behavior variables, only exercise was correlated both with optimism (or stress) and with gestational age (or birth weight), as required for its inclusion in the model. Thus, neither smoking nor nutrition was examined further. Exercise was added to the model intermediate to optimism and gestational age.

Summary of the structural model. The complete model, depicted in Figure 1, fit well, $\chi^2(73, N = 129) = 79.03, p = .29$, CFI = 0.96, root mean square error of approximation (RMSEA) = 0.03. Its components can be summarized as follows. Optimism and stress are highly (and inversely) correlated. Of these two variables, however, only optimism predicts birth outcome, namely birth weight. Birth weight is also predicted by gestational age and inversely by non-White ethnicity. Gestational age is predicted by exercise and inversely predicted by medical risk. The impact of optimism on birth weight ($\beta = .19$) is comparable to the impact of ethnicity ($\beta = -.18$), although gestational age is the strongest predictor of birth weight ($\beta = .56$), as expected. The model explains 39% of variance in birth weight and 19% of variance in gestational age.

Additional Analyses

Because of the possibility that stress and optimism might exert interactive effects on birth outcome, regression analyses were conducted. These effects were not significant.

Separate logistic regression analyses were conducted to determine whether the variables predicting gestational age and birth weight in the structural equation model predicted low birth weight or preterm delivery as clinically defined. For the purpose of these analyses, and consistent with obstetric definitions of low birth weight and preterm delivery, birth weight was dichotomized at less than 2,500 g; gestational age was dichotomized at fewer than 37 weeks. Clinically defined low birth weight was predicted only by gestational age ($B = -.76, p < .001, R = -.40$); preterm delivery as clinically defined was predicted by medical risk ($B = .33, p = .05, R = .14$) and by exercise ($B = -.78, p = .05, R = -.14$).

Discussion

Women who were least optimistic during pregnancy delivered lower birth weight infants, complementing a recent study conducted with socioeconomically disadvantaged women (Rini et al., 1999). Less optimistic women in the current study also experienced more stress, at a constant level throughout pregnancy, but stress itself did not affect birth outcomes. Furthermore, women at higher risk gave birth earlier, whereas non-White women delivered lower weight infants irrespective of gestational age, as is consistent with past studies (Lobel et al., 1992; Molfese, 1989; NCHS, 1997; Paneth, 1995).

The current findings suggest that optimism, particularly its absence, may be as important to maternal and fetal health as variables such as medical risk and ethnicity, which have traditionally garnered greater attention. Research suggests that optimism, which involves generalized, positive outcome expectancies, and constructive thinking, a related variable that involves the ability to think and solve problems in everyday life, can be learned (Park et al., 1997; Seligman, 1991). Park et al. found that women who evidenced greater constructive thinking experienced more positive states of mind and less anxiety and were less likely to use harmful substances during pregnancy. Both learned optimism and constructive thinking hold promise as means of intervention against adverse birth outcomes. However, replication of the present study is essential before recommendations can be based on its results, and generalizability to other groups of pregnant women remains to be demonstrated. For example, optimism may be particularly beneficial in high-risk pregnancy, in which a potent threat of adverse birth outcomes exists, but it might exert less impact in other pregnant women. Also, larger studies must be conducted to provide the necessary statistical power for determining whether optimism protects against clinically defined adverse birth outcomes.

Explanatory Mechanisms

We found that optimistic women may have experienced better birth outcomes in part because they exercised more frequently

Table 2
Correlations Among Sociodemographic and Study Variables

Variable	1	2[a]	3[b]	4[c]	5[d]	6	7	8	9	10	11	12	13	14	15	16	17
1. Age	—																
2. Education	.01	—															
3. Income	.11	.14	—														
4. Marital status	.00	.10	.21*	—													
5. Ethnicity	−.09	.11	−.22*	.07	—												
6. Medical risk	.15	−.12	−.01	−.11	−.20*	—											
7. Smoking	.01	−.16	−.14	−.13	−.03	−.11	—										
8. Exercise	−.08	.19*	.13	.05	−.04	−.05	−.11	—									
9. Nutrition	.05	.10	.09	.18*	−.12	−.08	−.06	.31**	—								
10. Optimism	−.04	.17	.19*	−.15	−.05	−.08	−.06	.20*	.20*	—							
11. Pregnancy distress	−.08	−.06	−.16	−.12	.04	.04	.12	−.14	−.21*	−.36*	—						
12. No. life events	.05	−.17	−.05	−.26**	.11	−.04	.12	−.11	−.28**	−.26**	.35**	—					
13. Life event distress	.18*	−.08	−.03	−.06	.18*	−.05	.16	−.12	−.16	−.21*	.29**	.76**	—				
14. Perceived stress	.06	−.17	−.19*	−.21*	.05	.15	.10	−.13	−.25**	−.57**	.56**	.43**	.33**	—			
15. Anxiety	.12	−.14	−.17	−.14	−.05	.18*	.18	−.06	−.18*	−.55**	.55**	.55**	.28**	.75**	—		
16. Birth weight	−.07	.13	.19	−.06	−.17	−.11	−.16	.13	−.02	.20*	−.01	−.07	−.02	.04	−.05	—	
17. Gestational age	−.15	.18*	.07	−.16	−.03	−.29**	−.06	.28**	.10	.13	−.05	.07	.04	−.02	−.10	.59**	—

[a] Coded as 1 = 11th grade or less, 2 = high school graduate, 3 = some college, 4 = college graduate, 5 = some graduate school, and 6 = graduate degree. [b] Annual household income in dollars, coded as 1 = less than or equal to $15,000, 2 = $15,001–$25,000, 3 = $25,001–$35,000, 4 = $35,001–$50,000, and 5 = more than $50,000. [c] Coded as 0 = single, divorced, separated, or widowed and 1 = married or living together as if married. [d] Coded as 0 = White and 1 = non-White.
* $p < .05$. ** $p < .01$.

during pregnancy, and exercise was associated with greater gestational age. The exercise variable was not ideal, because it was based on self-report and was composed of only two items with untested validity. However, exercise in pregnancy may be beneficial by reducing levels of hypothalamic, pituitary, and placental hormones, which are thought to trigger labor (Hobel, Dunkel-Schetter, & Roesch, 1998; Wadhwa, Porto, Garite, Chicz-DeMet, & Sandman, 1998), or by reducing the cardiovascular and other physiological reactivity that is associated with adverse birth outcomes (see Dunkel-Schetter et al., in press). Furthermore, exercise may be a proxy for salutary health practices more generally. For example, good nutrition, which is also posited to play a role in the timing of delivery (Casanueva, Vadillo-Ortego, Pfeffer, & Tejero, 1998), was significantly correlated (r = .31) with exercise in this study, although nutrition itself did not mediate the impact of optimism on birth outcome.

Research has highlighted some of the other mechanisms by which optimism may confer health benefits. Enhanced immune function (F. Cohen et al., 1999; Segerstrom, Taylor, Kemeny, & Fahey, 1998) is one potentially important mechanism in the context of birth outcome (e.g., Garite, 1994; Kelly, 1995; Lockwood, 1994; Romero et al., 1994). Behavioral mechanisms include the adaptive ways that optimists cope with stress during pregnancy (Lobel, Yali, & Zhu, 1998; Lobel, Yali, Zhu, DeVincent, & Meyer, 2000). Although the present study adds to the accumulation of evidence that optimism yields important health benefits, there is surprisingly little research on the basic physiological and behavioral consequences of an optimistic outlook. Such research is especially vital in pregnant women, because there is some evidence that alterations of the intrauterine environment produced by prenatal psychosocial conditions may have permanent effects on the cognition, affect, and behavior of children over their lifetime (see review by Wadhwa, 1998).

The Role of Stress

This study suggests that the obstetric impact of chronic PNMS, which has been demonstrated in a variety of past studies, may be attributable to women's stable tendencies to view their lives as stressful. This finding is consistent with the observation that chronic stress appears across past studies to be a more potent predictor of adverse birth outcomes than acute or episodic stress (Dunkel-Schetter & Lobel, 1998; Lobel, 1994). Chronic stress may be a manifestation of underlying dispositions or traits. Alternatively, chronic stress may contribute to low optimism, although there is some evidence that optimism is robust even in the face of stressful experiences (Bromberger & Matthews, 1996; Scheier & Carver, 1985). Nevertheless, the current study results indicate that disposition, rather than stress per se, may be the contributor to adverse birth outcomes.

The failure to see direct effects of PNMS in this study may be for other reasons, however. One possibility is that women who comprised the current sample—those with education and financial resources—are relatively invulnerable to PNMS compared with the socioeconomically disadvantaged women, who constitute the samples of many previous studies illustrating impact of PNMS. An alternative possibility is that the stress measure used in the present study was not sufficiently sensitive. However, several points militate against this possibility. First, the operational definition of

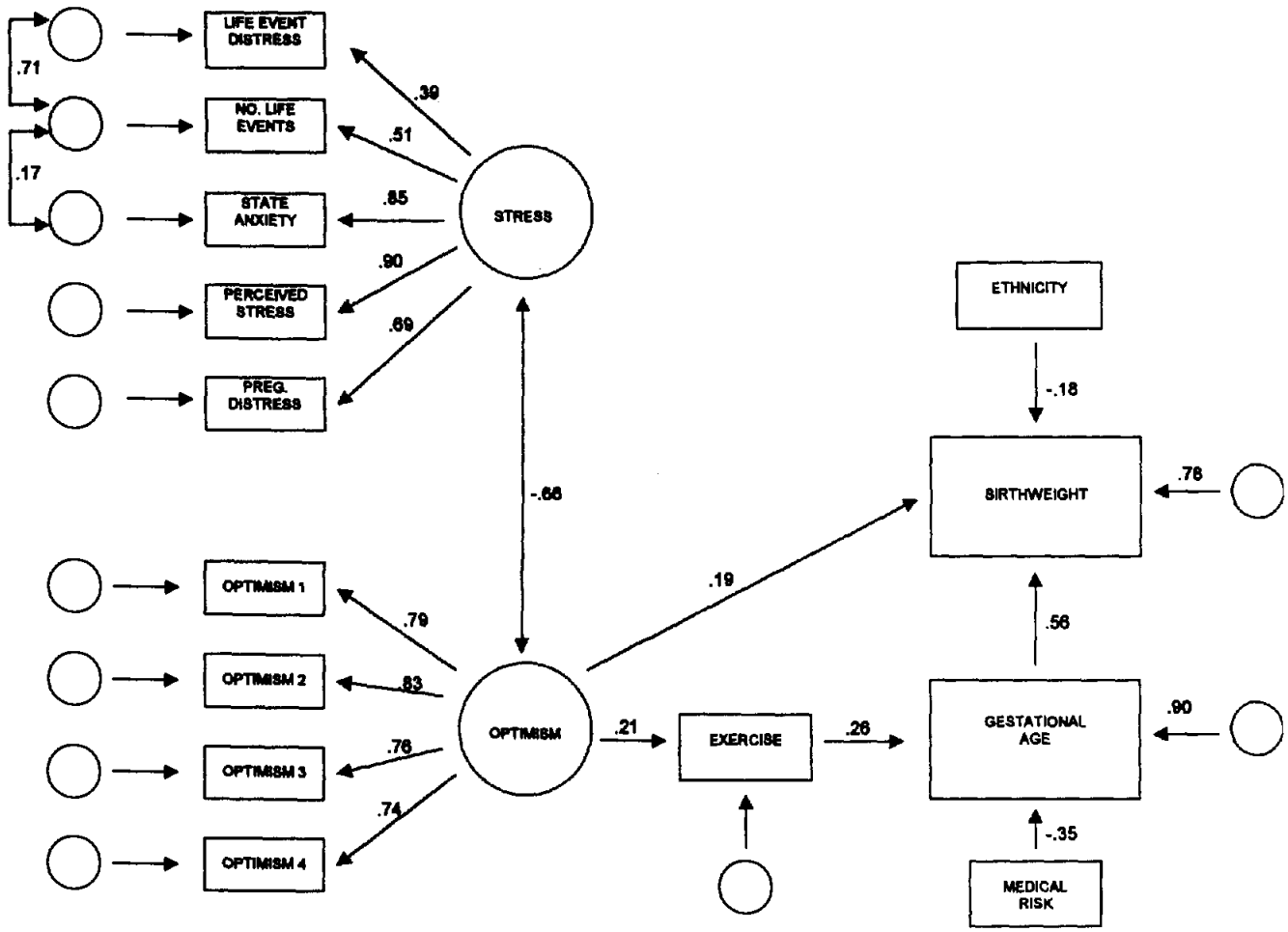

Figure 1. Structural model of the impact of stress, optimism, ethnicity, medical risk, and exercise on gestational age at delivery and birth weight, $\chi^2(73, N = 129) = 79.03$, $p = .29$, comparative fit index = 0.96; root mean square error of approximation = 0.03; all paths significant at $p < .05$ or less. Path coefficients are standardized. For the sake of simplicity, most coefficients for errors are not displayed. Ethnicity is coded so that 0 = White and 1 = non-White. Preg. = pregnancy.

PNMS used five highly related components, which were shown to form a cohesive latent factor. This operational definition is similar, although broader than that used in a previous study that found effects of PNMS on birth outcome (Lobel & Dunkel-Schetter, 1990; Lobel et al., 1992). Second, there was a strong inverse association between optimism and the more subjective indicators of stress such as state anxiety ($r = -.55$) and perceived stress ($r = -.57$), which increases confidence in the validity of the stress measures. In contrast, optimism was only minimally associated ($r = -.26$) with the number of life events reported by study participants, perhaps the most "objective" indicator of stress. Thus, we do not believe that inadequate measurement of stress can account for its lack of impact on birth outcomes in this study. Furthermore, we were able to examine the impact of stress independent of medical risk and ethnicity. Studies that do not include controls for variables that are often confounded with stress—such as medical risk or ethnicity—may produce artificially inflated estimates of the impact of PNMS on birth outcome (cf. Lobel, 1994). The fact that ethnic differences were detected with so crude a variable as used here and with so few non-White study participants suggests that the impact of ethnicity is especially powerful. Also, that ethnic differences in birth weight were found in this middle- to upper-class sample suggests that these are due to cultural and environmental factors as well as to differences in socioeconomic conditions (Blackmore et al., 1993). Further research with diverse samples is needed to examine such issues more thoroughly.

Conclusions

Although a growing body of evidence indicates that optimistic disposition is associated with health, the present study is one of few investigations that demonstrate impact of optimism on a health outcome measured objectively and prospectively. In addition to illuminating the role of optimism in birth outcomes, the results of this study can be used to support the search for other aspects of

health that are affected by disposition and related psychosocial factors and to extend our understanding of the reasons why optimistic individuals experience better health.

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