When So-Called Cozy Home and Mother's Womb Are Not Safe:

Intimate Partner Violence and Prenatal Maternal Stress

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Abstract of the Dissertation

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Prenatal maternal stress (PNMS) and intimate partner violence (IPV) are both associated with negative maternal and neonatal health outcomes. However, operationalization of these constructs has proved challenging due to the heterogeneity of stress and violence experiences. Little is known about the stability and change in occurrences of different types of IPV across time, and evidence for deleterious effects of PNMS and IPV on maternal and neonatal health is inconclusive. This dissertation aims to build and expand on prior research by addressing these limitations in three studies. Study 1 examined the validity of a multivariate model of PNMS across diverse women (*N* = 2,709) using multigroup confirmatory factor analysis. Study 2 examined the stability and change in occurrence of various types of IPV across pre-pregnancy, pregnancy, and postpartum periods using latent transition analysis. Finally, Study 3 used structural equation modeling to examine whether PNMS and prenatal IPV were associated with fetal distress during childbirth and unplanned cesarean delivery. Study 1 results confirmed the validity of the multivariate PNMS model, and revealed significant group differences in PNMS. Findings suggest that pregnancy is more stressful for younger, single, unemployed, less educated women with less income, women with an unintended pregnancy, and those with more pregnancy and birth experiences relative to their comparison groups. Study 2 identified three classes of women: those who experienced no IPV, predominantly sexual IPV, or physical IPV only. Presence of violence in one period increased the likelihood of violence in subsequent periods for all women. Physical violence prior to conception was more likely to continue during pregnancy among women with an unintended pregnancy than among those with an intended pregnancy. Women whose partners did not want their pregnancy were at a greater risk for initiation of physical violence during pregnancy than those with partners who wanted their pregnancy. Finally, findings from Study 3 showed that pregnancy specific stress independently contributed to fetal distress, and significantly predicted unplanned cesarean delivery controlling for medical risk. Implications of these findings for effective screening, intervention, and prevention programs are discussed.

Dedication Page

This dissertation is dedicated to the loving memory of my beloved mother, Sevda Cizmeli.

Mom, I kept my promise to you.

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List of Abbreviations

IPV	Intimate Partner Violence
PNMS	Prenatal Maternal Stress
CDC	Centers for Disease Control and Prevention
MGCFA	Multigroup Confirmatory Factor Analysis
CATIs	Computer-Assisted Telephone Interviews
NuPDQ	Revised Prenatal Distress Questionnaire
PDQ	Prenatal Distress Questionnaire
PLES	Prenatal Life Events Scale
STPI	State Trait Personality Inventory
PSS	Perceived Stress Scale
AMOS	Analysis of Moment Structures
SPSS	Statistical Product and Service Solutions
SAS	Statistical Analysis System
MLE	Maximum Likelihood Estimation
CFA	Confirmatory Factor Analysis
CFI	Comparative Fit Index
NFI	Normed Fit Index
RMSEA	Root Mean Square Error of Approximation
SEM	Structural Equation Modeling
PRAMS	Pregnancy Risk Assessment Monitoring System
WEB	Women's Experiences with Battering Scale
AAS	Abuse Assessment Screen

List of Abbreviations (cont'd)

LTA	Latent Transition Analysis
AIC	Akaike's Information Criterion
BIC	Bayesian Information Criterion
FHT	Fetal Heart Tracing

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When So-Called Cozy Home and Mother's Womb Are Not Safe:

Intimate Partner Violence and Prenatal Maternal Stress

Contrary to cultural connotations of home as a cozy and secure base, the home can be a dangerous place (Chrisler & Ferguson, 2006). A wealth of research shows that the home is the site of more violence against girls and women than any other location (Straus & Gelles, 1995). Each year approximately 1.5 million women are physically assaulted or raped in their home by an intimate partner (Tjaden & Thoennes, 2000). Partner violence is the leading cause of non-fatal injury among U.S. women (Abbott, Johnson, Koziol-McLain, & Lowenstein, 1995), and approximately one-third of female murder victims in the U.S. are killed by a current or former male intimate (Kellerman & Mercy, 1992).

Intimate partner violence (IPV) against women is a pervasive public health problem. Abused women's pain and suffering cannot be reduced into dollars and cents; however, numbers may help to demonstrate the devastating impact that violence against women has on society as a whole. For instance, according to the Centers for Disease Control and Prevention (CDC, 2003), annual medical costs associated with IPV are estimated to be over $ 44 million. Abused women tend to utilize health care services more often, and to have more Medicaid expenditures than non-abused women due to their abuse-related injuries and morbidity (e.g., Coker, Reeder, Fadden, & Smith, 2004). Despite their disproportional mental and physical needs, abused women are also more likely to be fired from their jobs than non-abused women because either they miss work or employers fear the abuser (Runge, 1998). The cost of medical care, mental health services, and lost productivity related to IPV was estimated to be more than $8.3 billion in 2003 (CDC, 2003; Max, Rice, Finkelstein, Bardwell, & Leadbetter, 2004).

Although IPV may affect any woman, studies suggest that women of reproductive age may be at a greater risk for it (e.g., Gelles, 1988). Prevalence estimates of IPV prior to, during, and/or after pregnancy show substantial variation due to differences in research designs, measures, and operational definitions employed, and populations sampled (Gazmararian, Petersen, Spitz, Goodwin, Saltzman, & Marks, 2000). Our current knowledge is insufficient to conclude whether women are at greater risk for IPV prior to, during, or after pregnancy, which also limits effectiveness of screening, intervention, and prevention programs.

Pregnancy offers a unique opportunity to assess and intervene against IPV. One reason is that abused women tend to utilize health care services more often than non-abused women due to their injuries. If they are screened for partner violence in prenatal care settings, they will have a greater likelihood of being detected. Moreover, prenatal care appointments will probably be the only interaction with health care providers for women with limited access to health care services (Campbell, 1998). Finally, the documented association between unintended pregnancy and IPV victimization (e.g., Keeling & Birch, 2004) also suggests that pregnancy offers a unique opportunity to identify and intervene against IPV. Examining IPV within the context of pregnancy may inform violence screening programs in health care clinics. Thus, this dissertation used pregnancy as a window of opportunity to examine IPV in the presence of individual and contextual factors, and aimed to build and expand on prior research on prenatal maternal stress and IPV. Three studies comprise the dissertation. Each study resolves some limitations of previous research by employing well-established measures and advanced methodologies to test predicted hypotheses.

Study 1 examined the validity of a theoretically-founded, multivariate model of prenatal maternal stress (PNMS) in a large, representative sample of diverse women (N = 2,709). It was hypothesized that the multivariate model of PNMS (1) would fit the data well, (2) would be invariant across diverse women, allowing meaningful group comparisons in the experiences of PNMS, and (3) would reveal significant group differences in the intensity of PNMS based on individual and contextual factors such as age, ethnicity, and pregnancy intendedness.

Study 2 examined the stability and change in occurrence of various types of IPV within individual women across pre-pregnancy, pregnancy, and the postpartum period. The study used predominantly a person-centered methodology (i.e., latent transition analysis) to capture the heterogeneity of violence experiences, and hypothesized that (1) a latent model of IPV types would be defined based on shared characteristics of IPV experiences, and (2) this model could be used to accurately predict stability and change in type of IPV across pre-pregnancy, pregnancy, and postpartum in the presence of individual and contextual factors such as marital status and pregnancy intendedness.

Finally, Study 3 investigated associations of PNMS and IPV with fetal heart tracing abnormalities (an indicator of fetal distress during childbirth) and unplanned cesarean delivery. It was hypothesized that both PNMS and IPV would directly and indirectly be associated with fetal heart tracing abnormalities and unplanned cesarean delivery, after controlling for maternal risk for these outcomes.

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Conceptualization and Measurement of Prenatal Maternal Stress in Diverse Women:

A Multigroup Confirmatory Factor Analysis Approach

Pregnancy is a major life event characterized by physiological, social, and emotional changes. While the majority of women adapt well to these changes, approximately ¼ of women report high stress during pregnancy regardless of their medical risk status (Yali & Lobel, 1999). The experience of pregnancy is affected by a number of factors including the range of roles a woman fulfills in her family and work life, pregnancy-related strains, concerns about the labor and delivery and health of the fetus, and the impending responsibilities of motherhood (Stanton, Lobel, Sears, & DeLuca, 2002). Furthermore, pregnancy may be a stressful event for some women depending on their age, socioeconomic resources, availability of social support, obstetric history, and whether their pregnancy is planned or desired (Lederman, 1984; Maxson & Miranda, 2011).

Converging evidence both from animal and human studies indicates that stress during pregnancy is a risk factor for adverse birth outcomes such as preterm delivery (at less than 37 weeks gestation) and low birthweight (less than 2500 grams), the major causes of morbidity and mortality in newborns with an enormous toll on women, children, families, the health care system, and society (Alderdice & Lynn, 2009; Beydoun & Saftlas, 2008; Glynn, Dunkel-Schetter, Hobel, & Sandman, 2008; Lobel, Cannella, Graham, DeVincent, Schneider, & Meyer, 2008). Prenatal maternal stress (PNMS) has been shown to affect maternal and neonatal outcomes through health impairing behaviors and changes in neuroendocrine, immune, vascular, and metabolic functioning (Arck, 2010; Coussons-Read et al., 2012; McEwen, 2008; Rondo, Ferreira, Nogueira, Ribeiro, Lobert, & Artes, 2003).

PNMS has received a great deal of attention by researchers over the past three decades, and it has been operationalized in a variety of ways. A majority of researchers have defined it as a form of *general stress,* and assessed major life events experienced during pregnancy as the proxy of this definition (see review by Lobel, 1994). A more recent approach employed by a few researchers has been the use of *multivariate* conceptualization and operationalization of stress including stressful stimuli, responses, and appraisals (Lobel et al., 2008; Lobel, Hamilton, & Cannella, 2008). Although the predictive validity of these approaches has been documented by a number of studies (e.g., Hobel, Dunkel-Schetter, Roesch, Castro, & Arora, 1999; Rini, Dunkel-Schetter, Sandman, & Wadhwa, 1999), each approach has its own limitations. The pregnancy experience has unique stressors which a general stress construct fails to capture. Pregnant women are commonly concerned about physical symptoms, bodily changes, labor and delivery, parenting, and changes in interpersonal relationships (Yali & Lobel, 1999). Although general stress tends to co-occur with stress specific to pregnancy, it is highly plausible to argue that these two concepts do not measure the same construct, and that prediction of adverse birth outcomes using a general stress approach may be vulnerable to contamination by variables non-specific to the pregnancy experience (DiPietro, Ghera, Costigan, & Hawkins, 2004; Lobel, DeVincent, Kaminer, & Meyer, 2000; Lobel et al., 2008). On the other hand, multivariate approaches have been shown to be conceptually more powerful with greater predictive validity. Some suggest that studies using these approaches offer the most compelling and consistent evidence about the deleterious effects of stress on adverse birth outcomes (e.g., Lobel et al., 2008). However, when multivariate approaches are not based on well-founded theories and are not tested for theoretical and empirical validity, their greater predictive validity may come at the expense of theoretical clarity and validity. Aggregating different definitions of stress into a single global factor may result in inclusion of some irrelevant variables which might pose risks for theoretical validity, and may restrict our ability to determine the effects of individual stress components on the outcomes predicted (Depue & Monroe, 1986; Monroe & Simons, 1991). Moreover, theoretical specificity regarding stress components in a multivariate definition is difficult to achieve unless independent and interactive effects of stress components are tested using powerful statistical techniques such as structural equation modeling. As a result of these variations in operationalization of PNMS, our current knowledge about which aspects of PNMS are strongly associated with adverse birth outcomes is very limited (Dunkel-Schetter & Glynn, 2011).

A central focus of studies on PNMS has been to examine individual-level predictors (e.g., age, ethnicity, education, etc.) of high stress during pregnancy in an effort to identify those who are at higher risk of adverse birth outcomes. For instance, several researchers have reported striking ethnic disparities in stress levels and associated outcomes such as preterm delivery and low birthweight, with African American women reporting higher levels of prenatal stress and having greater risk of these adverse birth outcomes than White women (Kung, Hoyert, Xu, & Murphy, 2008; Lespinasse, David, Collins, Handler, & Wall, 2004; Parker Dominguez et al., 2008; Rosenberg, Palmer,Wise, Horton, & Corwin, 2002). A common practice by those researchers is to compare different groups on stress variables by assuming that those measures have the same structure, and operate in the same way across groups. However, legitimate comparisons of means or structural relations across groups require support for measurement invariance across groups (Meredith, 1993) as stress measures may not assess the same construct, in the same way, across groups compared. Furthermore, certain aspects of stress may be culture- or group-specific, resulting in variations in stress and stress response that might not be captured equally by the instruments used. When comparability of stress scores across variables or groups is not established, the statistical conclusions drawn from these scores may be invalid (Hancock, Lawrence, & Nevitt, 2000; McDonald, Seifert, Lorenzet, Givens, & Jaccard, 2002).

Research designs incorporating multiple measures of PNMS which are valid and reliable across different groups may enable researchers to better identify health effects. However, operationalization of such multivariate stress definitions has proved to be challenging for researchers. Thus, the purpose of the current study was to test the validity of a theoretically well-founded, multivariate definition of PNMS comprised of stress stimuli, appraisals, and responses among diverse women. Following the work of Lobel and colleagues (e.g., Lobel et al., 2008), PNMS was conceptualized as a latent variable represented by pregnancy-specific distress, state anxiety, perceived stress, life events distress, and number of major life events (see Figure 1.1). This multivariate operationalization of PNMS incorporates the three most prominent approaches to stress definition: stimulus, response, and appraisals (Hobfoll, 1989; Lazarus & Folkman, 1984). Life events during pregnancy represents the stimulus or environmental component of stress; pregnancy-specific distress, perceived stress and life events distress represent appraisals of stress, and state anxiety represents emotional responses to stress.

Using data from a population-based, retrospective research design, the current study aimed to examine (1) the *fit* of this multivariate model of PNMS to the data (i.e., the validity of the model within the sample), (2) the *appropriateness* of this model for various groups of women (i.e., the measurement invariance of the model across groups of women), and (3) *group differences* in the mean scores of observed and latent variables. Multigroup confirmatory factor analysis (MGCFA) was used to test for measurement invariance of the hypothesized model and group differences in mean scores for observed and latent variables. MGCFA involves setting cross-group constraints in a successive manner, and comparing the fit of a more restricted model to that of less restricted models (Byrne, Shavelson, & Muthén, 1989; Steenkamp & Baumgartner, 1998). Testing for measurement invariance enables a determination of whether (1) measurement parameters such as factor loadings and item intercepts are the same across groups; (2) there are response biases in a particular group; (3) observed mean differences accurately reflect latent mean differences, and (4) the same construct is measured in all groups (Byrne, 2009). It was hypothesized that the multivariate model of PNMS would fit well to study data; be invariant across women differing in age, ethnicity, education, marital status, income, employment status, pregnancy intendedness, parity, and gravidity; and allow meaningful comparisons of observed and latent means of stress measures across these groups.

Method

Participants

The study sample consisted of 2,709 female residents of Black Hawk, Johnson, Polk and Scott counties in Iowa who delivered a live born infant between May 1, 2002 and June 30, 2005. Women were included if they (a) were above the age of 18 at the time of delivery, (b) spoke English, (c) did not have Type 1 or Type 2 diabetes mellitus, systemic lupus, or chronic renal disease, or (d) a multiple birth. Adolescents were excluded because they face unique medical and psychosocial issues during pregnancy (Coley & Chase-Lansdale, 1998; Kingston, Heaman, Fell, & Chalmers, 2012); women with chronic health conditions and multiple births were excluded because they tend to experience higher levels of prenatal stress (Choi, Bishai, & Minkovitz, 2009; Katon, Russo, Gavin, Melville, & Katon, 2011). As shown in Table 1.1, the sample was predominantly White (88.4%), married (86.9 %) with an average age of 28.32 years (*SD* = 5.45).

A majority of women reported having more than high school education (80.2%) with moderate to-high income (67%). Approximately 58% of women reported that their pregnancies were intended, and 8.3% of these women were in infertility treatment before they became pregnant.

Procedure

Participant recruitment. Eligible participants were identified from Iowa birth certificate files. Telephone contact was attempted within 3 to 6 months following delivery. The study was described as consisting of a one-hour telephone interview which would cover medical and reproductive history and health behaviors during pregnancy. Compensation of $30 was offered, to be paid upon completion of the interview.

Of the 7,202 potential respondents identified from birth certificates, 4,250 (59 %) women were reached by phone. Of these, 12.9 % (N = 548) were ineligible for participation based on the study exclusion criteria. Over 77 % (N = 2,866) of the 3,702 eligible women agreed to participate, and of these, 94.5 % (N = 2,709) completed the computer-assisted telephone interview.

Computer-assisted telephone interviews (CATIs). Data were collected by CATIs between August 2002 and January 2006. This method was chosen for several reasons. First, telephone interviewing typically elicits as good or possibly better response rates and more accurate reports of stress than face-to-face interviews (Feveile, Olsen, & Hogh, 2007; Smith, 1989). Second, telephone interviewing was considered especially convenient for women who have recently delivered a child. Third, it is more cost effective and less time consuming than face-to-face interviews. All interviews were conducted by trained, experienced female interviewers. Verbal consent was obtained prior to interviews and participants' current mailing address was requested for the delivery of written consent forms and the compensation for participation.

Measures

Demographic characteristics. Participants reported their age at delivery (in years), ethnicity (coded as White, Black, Asian or Pacific Islander, or mixed race), level of education (coded as high school equivalent or less, some college, associate degree or vocational school, college graduate, or graduate/professional school), marital status (coded as married or single), annual household income (reported in dollars, recoded as poor, near poor to low income, moderate income, high income based on an income-poverty ratio calculated by dividing participants' annual household income by number of people living in their household), employment status during pregnancy (coded as unemployed or employed), parity, gravidity (continuous), and pregnancy intendedness of participants (coded as intended or unintended). Pregnancy intendedness of women was assessed by asking them (1) whether they wanted to be pregnant at that time or sooner; or later; or did not want to be pregnant then or at any time in the future, (2) whether they felt excited about having the baby once they found out that they were pregnant. Those who wanted to be pregnant later or did not want pregnancy then or at any time in the future and those who did not report being excited about having the baby were coded as women with an unintended pregnancy.

Pregnancy-Specific Distress. The Revised Prenatal Distress Questionnaire (NuPDQ; Lobel et al., 2008) was used to assess pregnancy-related distress in the present study. It included 17 items. The NuPDQ and its predecessor, the Prenatal Distress Questionnaire (PDQ), have been shown to have high internal consistency and predictive validity in pregnant women

(Alderdice, Lynn, & Lobel, 2012). Participants were asked to indicate if they felt bothered, upset or worried about different aspects of pregnancy on a 4-point scale ranging from "not at all" (1) to "very much" (4). Sample items include "(Did you feel bothered, upset, or worried) about changes in your weight and body shape during pregnancy?," "about whether you might have an unhealthy baby?," and "about physical symptoms of pregnancy such as vomiting, swollen feet, or backaches?." A total NuPDQ score for each participant was calculated by summing item responses. The scale was internally consistent, Cronbach's α = .80.

Major Life Events. Stressful life events were measured by the Prenatal Life Events Scale (PLES) adapted from previous research with pregnant women (Lobel, Dunkel-Schetter, & Scrimshaw, 1992; Lobel et al., 2000). The PLES has been shown to correlate well with other indicators of prenatal stress such as scores on the Perceived Stress Scale and the Prenatal Distress Questionnaire (Lobel, et al., 2000, 2008). Participants were asked to report the occurrence of 28 life events that they or a close family member or friend 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 reported, participants were asked to indicate how undesirable or negative the event was on a 4-point scale ranging from "not at all" (0) to "very much" (3). Two indices were computed from the life events instrument: (1) number of life events during pregnancy, and (2) a mean life event distress score. The mean life event distress score was obtained by summing distress ratings and dividing by the total number of life events reported. The choice to use mean distress rather than a distress sum was made to ensure that the stressfulness of life events would be independent of the number of events experienced. Participants who reported no events were assigned an event distress score of zero.

State Anxiety. The 10-item State Anxiety subscale of the State Trait Personality Inventory (STPI) (Spielberger, 1995) measures how anxious one feels at the moment. In a sample of working women, the STPI had high internal consistency (α = .93) and a high correlation (*r* = .95) with its longer, parent measure, the State Form of Spielberger's State-Trait Anxiety Inventory (Spielberger, 1983; Spielberger, 1995). The STPI has also been shown to have high internal consistency (α = .95) and convergent and predictive validity in samples of pregnant women (Hamilton & Lobel, 2008; Lobel et al., 2000, 2008). Participants were asked to indicate the applicability of items such as "I felt nervous," "I was worried," and "I felt calm" during their pregnancy on a 4-point scale ranging from "not at all" (0) to "very much" (3). Four items were reverse-scored (e.g. "I felt calm"), and a total state anxiety score for each participant was calculated by summing item responses. The scale was internally consistent, Cronbach's α = .87.

Perceived Stress. A four-item version of the Perceived Stress Scale (PSS; Cohen & Williamson, 1988) was used to measure perceptions of stress during pregnancy. It has been shown to have high reliability (α = .74 - .89) in samples of pregnant women (Lobel et al., 2000; Lobel & Dunkel-Schetter, 1990). Participants were asked to report how frequently they felt unable to overcome difficulties in their lives during their pregnancy on a 5-point scale ranging from "never" (1) to "very often" (5) with two reverse-scored items. A total perceived stress score for each participant was calculated. The scale was internally consistent, Cronbach's α = .78.

Data Analytic Strategy

Analyses were performed using SPSS 19.0 and AMOS 18.0. Exploratory data analysis was conducted using SPSS and MGCFA analyses were performed with maximum likelihood estimation (MLE) using AMOS 18.0. Data were first examined for missing values. Seventeen cases, each with one missing value, were identified and the missing values were replaced with the series mean. Univariate indices of skewness and kurtosis resulted in z- values greater than 1.96 for the pregnancy-specific distress and number of major life events variables. As recommended by Tabachnick and Fidell (2007), square root and log transformations were performed on the positively skewed distributions of the number of major life events and pregnancy-specific distress variables, respectively. As a pre-requisite for using MLE, multivariate normality was evaluated by means of Mardia's coefficient and its critical ratio. A critical ratio value greater than 1.96 at the 5 % level of significance was considered a violation of the multivariate normality assumptions in the data (Tabachnick & Fidell, 2007). Data met the assumptions of multivariate normality.

First, the fit of the hypothesized measurement model to the data was tested through Confirmatory Factor Analysis (CFA). The model fit was evaluated by multiple fit indices which included the Chi-square test, normed Chi-square (CMIN/df ratio), Comparative Fit Index (CFI), Normed Fit Index (NFI), and Root Mean Square Error of Approximation (RMSEA). The Chi-square test and the RMSEA tend to produce less accurate results with large sample sizes and complex models, respectively. Therefore, in addition to these indices, the normed Chi-square, the CFI, and the NFI, which are insensitive to sample size and model complexity, were used to evaluate model fit (Byrne, 2009; Hu & Bentler, 1999). A non-significant Chi-square value, a CMIN/df ratio smaller than 5, CFI and NFI values greater than .95, and an RMSEA value less than .06 with a non-significant *p* value for the test of close fit were used as indicators of good model fit (Hu & Bentler, 1999; Kline, 2005; Tabachnick & Fidell, 2007). As suggested by Tabachnick and Fidell (2007), standardized residuals and modification indices were also examined for values above 2.0. After a well-fitting baseline model was established, the multigroup equivalence of this model was examined across age (recoded as 18-28 years vs. 29+ years using a median split), ethnicity (recoded as White vs. non-White), education (recoded as ≤ high school vs. > high school), marital status (single vs. married), income (recoded as poor-to-low income vs. moderate-to-high income), employment status (unemployed vs. employed), pregnancy intendedness of participants (intended vs. unintended), parity (recoded as 0-1 vs. 2+ using a median split), and gravidity (0-2 vs. 3+ using a median split).

Results

Descriptive statistics and correlations among study variables are displayed in Table 1.2 and 1.3, respectively. Corroborating the findings of previous studies with pregnant women (e.g., Lobel et al., 2008), significant, positive correlations were found among pregnancy-specific distress, state anxiety, perceived stress, number of life events, and life events distress. Moreover, participants' annual household income and age at delivery were significantly and negatively related to the stress variables. Parity was positively associated with number of life events, life events distress, age, and parity, and negatively associated with pregnancy-specific distress and state anxiety. Gravidity was positively associated with perceived stress, number of life events, life events distress, and age, and negatively associated with pregnancy-specific distress and state anxiety.

Testing the measurement model. The initial, hypothesized measurement model of PNMS did not fit the data well. The Chi-square test was significant, χ^2 (5) = 260.26, p <.001, the CMIN/df ratio (52.05) was above the maximum cut off ratio of 5, values for CFI (.873) and NFI (.871) were less than .95, and RMSEA value was equal to .14 (90 % CI = .12-15; PClose = .00). Standardized residual covariances ranged from .04 to 12.40 and a majority of covariances were above the cut-off value of 2.0 suggested by Tabachnick and Fidell (2007). Examination of modification indices suggested several theoretically meaningful changes to the model to improve its fit. In order to achieve the most parsimonious model, stepwise modifications were made and the model fit was assessed at each step.

As the first step, covariance between the error terms for state anxiety and pregnancy-specific distress (e1 and e2) was added to the model. The Chi-square test was significant, χ^2 (4) = 44.09, p = .003, the CMIN/df ratio (11.02) was above the maximum cut off ratio of 5, indicating poor model fit. CFI (.983) and NFI (.981) values were above .95, and the RMSEA value was equal to .06 (90 % CI = .04-08; PClose = .12; however, the residual covariance between state anxiety and perceived stress was above the cut off value of 2.0. Based on examination of modification indices, the second step involved adding another error covariance to the model, between state anxiety and perceived stress (e1 and e5). All fit indices -- except the Chi-square test which may produce inaccurate results with a large sample size -- indicated good fit for this modified model, χ^2 (3) = 14.18, p = .003; CMIN/df ratio = 4.73; CFI = .992; NFI = .991; RMSEA= .04 (90 % CI = .02-.06; PClose = .84). Results confirmed the appropriateness of modeling prenatal maternal stress as a latent variable represented by the five observed measures, pregnancy-specific distress, state anxiety, perceived stress, number of life events, and life events distress. The modified model with standardized estimates is presented in Figure 1.2. Factor loadings for all of the observed variables were significant (p <.001). Number of major life events accounted for 73.7 % of variance in the latent variable of prenatal maternal stress, life events distress 52%, pregnancy-specific distress 15.5 %, state anxiety 2.2 % and perceived stress 1.4 %.

Testing for multigroup measurement invariance. At this stage of the analysis, the model was tested for multigroup equivalence across age, ethnicity, education, marital status, income, employment status, pregnancy intendedness, parity, and gravidity. Descriptive statistics for each group compared are given in Table 1.4. Following the steps recommended by Byrne (2009), the fit of the hypothesized model was tested for each group separately. After establishing a *baseline model*, that is, the most parsimonious and theoretically meaningful model for each group separately (see Figure 1.2), the measurement invariance of this model was examined by testing three invariance models: Configural invariance, metric invariance, and scalar invariance.

Model 1: Configural invariance. Configural model invariance tests whether individuals from different groups conceptualize the construct of PNMS in the same way. To test this, the baseline model fit across groups was examined simultaneously using multigroup CFA. All factor loadings were set free to vary in this model. For model identification purposes, only the factor loading of state anxiety was constrained to 1. The fit of the configural model was assessed and used as a baseline against which subsequently specified invariance models were compared. When invariance of the configural model is achieved, it suggests that the hypothesized factor structure is similar across groups, although not necessarily equivalent.

Model 2: Metric invariance. This model, also called *weak invariance*, tests whether different groups respond to the stress measures in the same way. In other words, it examines if the strength of relations between stress measures and their underlying construct are the same across groups. Metric invariance is achieved when the magnitudes of factor loadings (i.e., regression coefficients) are equal across groups. Equivalence of factor loadings indicates that the latent variable is related to the observed variables in the same way across groups (Reise, Widaman, & Pugh, 1993).

After fulfillment of the prerequisite of configural invariance, metric invariance was tested by constraining all factor loadings to be equal across groups and by comparing the fit of this more restricted model with the baseline model for each group using CFI (ΔCFI) and Chi-square difference ($\Delta \chi^2$) tests. A non-significant $\Delta \chi^2$ value and a ΔCFI value smaller than .01 was interpreted as evidence of measurement invariance across groups (Cheung & Rensvold, 2002). When the two difference tests resulted in contradictory conclusions, a decision about model invariance was made based on the ΔCFI value since $\Delta \chi^2$ may be sensitive to sample size (Cheung & Rensvold, 2002). As suggested by Byrne (1989), when full metric invariance was not supported, constraints on factor loadings were removed progressively across groups until partial invariance was achieved. When full or at least partial metric invariance was established, the model was tested for scalar invariance.

Model 3: Scalar invariance. This model, also known as *strong invariance*, tests whether mean differences at the observed level accurately reflect the mean differences at the latent level. If this is not the case, measurement bias is evident; therefore, scalar invariance is a prerequisite for group comparisons (Byrne et al., 1989). The scalar invariance of the PNMS model was tested by constraining the intercepts of observed variables to be equal across groups. The fit of this more restricted model was compared to that of the metric model using $\Delta \chi^2$ and ΔCFI values.

Goodness of fit statistics for configural, metric, and scalar invariance models across groups can be found in Table 1.5. When full scalar invariance was not supported, constraints on item intercepts were removed progressively across groups until partial invariance was achieved. Byrne (1989) argues that full metric invariance is not necessary for meaningful group comparisons, and suggests that legitimate comparisons across groups can still be made under partial invariance provided that parameter estimates for at least one item in the model are completely invariant. Therefore, when full or at least partial scalar invariance was supported, subsequent analyses involved examination of group differences in means at the observed and the latent levels (see Table 1.6 and 1.7 for differences in the latent and observed variables).

Results of measurement invariance tests and multigroup comparisons

Age (18-28 years vs. 28+ years). The model was a good fit to data for both younger, χ^2 (3) = 7.598, p = .055; CMIN/df ratio = 2.533; CFI = .996; NFI = .993; RMSEA = .03 (90 % CI = .00-.06; PClose = .801), and older women (χ^2 (3) = 10.097, p = .018; CMIN/df ratio = 3.37; CFI = .992; NFI = .989; RMSEA = .04 (90 % CI = .02-.07; PClose = .60). Evidence for full metric invariance revealed that magnitudes of the paths for state anxiety, pregnancy-specific distress, number of major life events, life events distress, and perceived stress were the same across younger and older women. The full scalar invariance was not established for the model; however, partial scalar invariance was supported after removing the constraints on the intercepts of pregnancy-specific distress, number of major life events, and life events distress. Observed mean comparisons revealed that younger women scored significantly higher on state anxiety, pregnancy-specific distress, number of major life events, and life events distress than older women. Latent mean comparisons confirmed that younger women had significantly higher PNMS as compared to older women (M = .192, SE = .036, CR = 5.250, p < .001).

Ethnicity (White vs. non-White). The model fit well to the data in both subsamples, χ^2 (3) = 11.606, p = .009; CMIN/df ratio = 3.87; CFI = .995; NFI = .993; RMSEA = .035 (90 % CI = .01-.06; PClose = .86) for White women, and χ^2 (3) = 3.028, p = .387; CMIN/df ratio = 1.01; CFI = 1.0; NFI = .991; RMSEA = .00 (90 % CI= .00-.09; PClose = .67) for non-White women. Evidence for full metric invariance suggested that the magnitudes of path coefficients were equal across White and non-White women. Full scalar invariance was not supported; however, partial scalar invariance was achieved after allowing the intercepts of pregnancy specific stress and number of major life events to vary freely across these groups. Non-White women reported significantly more life events, and higher levels of pregnancy-specific distress, perceived stress, and life events distress than White women. Non-White women had significantly higher mean scores than White women at the latent level as well (M = .218, SE = .046, CR = 4.764, $p < .001$).

Education (≤ high school vs. > high school) The hypothesized measurement model fit well in both subsamples, χ^2 (3) = 3.349, p = .341; CMIN/df ratio = 1.12; CFI = .999; NFI = .992; RMSEA = .01 (90 % CI = .00-.08; PClose = .76) for women with high school or less education, and χ^2 (3) = 10.513, p = .015; CMIN/df ratio = 3.504; CFI = .995; NFI = .993; RMSEA = .03 (90 % CI = .01-.06; PClose = .86) for women with more than high school education. The model had partial metric invariance after removing equality constraints on the factor loadings of pregnancy-specific distress, number of major life events, and perceived stress, and the model exhibited partial scalar invariance after allowing the intercepts of pregnancy specific distress, life event distress, and number of major life events to vary freely. The magnitudes of path coefficients were equal across the groups. However, significant group differences were found at the observed and latent levels: Women with less education reported more major life events, and higher levels of pregnancy-specific distress and life events distress than those with more education. Additionally, women with less education had higher PNMS (M = .280, SE = .052, CR = 5.420, $p < .001$).

Marital status (single vs. married). The model resulted in good fit for both single, χ^2 (3) = 3.05, p = .384; CMIN/df ratio = 1.02; CFI = 1.0; NFI = .985; RMSEA = .01 (90 % CI = .00-.10; PClose = .64), and married women, χ^2 (3) = 16.623, p = .001; CMIN/df ratio = 5.54; CFI = .991; NFI = .990; RMSEA = .04 (90 % CI= .02-.07; PClose = .64).

Partial strong invariance was achieved across these groups after allowing the intercepts for pregnancy-specific distress and life events distress to vary. Single women had significantly more major life events, and higher levels of state anxiety and life events distress than married women. Similarly, single women reported significantly higher levels of PNMS than married women (M = .401, SE = .083, CR = 4.845, $p < .05$).

Income (poor-to-low vs. moderate-to-high income). The model exhibited good fit in both income groups, χ^2 (3) = 1.345, p = .718; CMIN/df ratio = .448; CFI = 1.0; NFI = .998; RMSEA = .00 (90 % CI = .00-.04; PClose = .98) for those with poor-to-low income, and χ^2 (3) = 16.782, p = .001; CMIN/df ratio = 5.59; CFI = .989; NFI = .986; RMSEA = .05 (90 % CI = .03-.07; PClose = .44) for those with moderate-to-high income. Partial metric invariance and partial scalar invariance were achieved for the model after setting free the factor loadings of pregnancy-specific distress and number of major life events, and the intercepts of pregnancy-specific distress, life events distress, and number of major life events, respectively. Women with poor-to-low income on average reported significantly more major life events, and higher levels of pregnancy-specific distress and life events distress than those with moderate-to-high income. Women with less income also had higher PNMS than those with moderate-to-high income (M = .295, SE = .058, CR = 5.096, $p < .001$).

Employment status (unemployed vs. employed). The model was a good fit to the data in both subsamples of employed (χ^2 (3) = 13.439, p = .004; CMIN/df ratio = 4.48; CFI = .993; NFI = .991; RMSEA= .04 (90 % CI= .02-.06; PClose = .72) and unemployed women (χ^2 (3) = 4.606, p = .203; CMIN/df ratio = 1.53; CFI = .997; NFI = .991; RMSEA= .03 (90 % CI = .00-.08; PClose = .64). The factor structure and factor loadings other than item intercepts were the same across these groups, and modifications to the model, which included removal of the constraints on the intercept of number of major life events, resulted in partial scalar invariance across the groups. Unemployed women reported significantly higher pregnancy-specific distress, and lower life events distress with fewer major life events compared to those employed. Women who were unemployed during their pregnancy also had significantly higher PNMS than those employed (M = .106, SE = .031, CR = 3.438, p < .001). Follow up analyses using Chi-square test showed that women unemployed during their pregnancy were significantly more likely to have poor-to-low income than those employed ($n_{employed, low income}$ = 584 vs. $n_{employed, high income}$ = 1550; $n_{unemployed, low income}$ = 304 vs. $n_{unemployed, high income}$ = 239; χ^2 (3, N=2677) = 163.63, p <.001).

Pregnancy intendedness (intended vs. unintended). The hypothesized measurement model fit well in both subsamples of women with intended (χ^2 (3) = 7.138, p = .068; CMIN/df ratio = 2.38; CFI = .996; NFI = .994; RMSEA= .03 (90 % CI= .00-.06; PClose = .86) and unintended pregnancy (χ^2 (3) = 3.816, p = .282; CMIN/df ratio = 1.27; CFI = .999; NFI = .995; RMSEA = .01 (90 % CI = .00-.05; PClose = .92). The model had partial metric invariance across these groups as a result of removing the equality constraints on the factor loadings of pregnancy specific distress, life events distress, and number of major life events. Similarly, partial scalar invariance was supported after removing the equality constraints on the intercepts of these variables and of state anxiety. Women with unintended pregnancy reported significantly more life events, greater life events distress, and pregnancy-specific distress than those with intended pregnancy. Latent mean comparisons showed that those who had an unintended pregnancy had greater PNMS than those with an intended pregnancy (M = .239, SE = .046, CR = 5.177, p < .001). Follow-up analyses using logistic regression showed that younger women (OR = 2.05, 95% CI = 1.68-2.50, p <.001), women with less education (OR = 1.57, 95% CI = 1.22.-2.02,

$p < .001$), and women with lower income (OR = 2.11, 95% CI = 1.69.-2.64, $p <.001$) were significantly more likely to have an unintended pregnancy relative to their comparison groups.

Parity (para 0-1 vs. 2+). The model resulted in good fit across both subsamples (χ^2 (3) = 10.917, p = .012; CMIN/df ratio = 3.64; CFI = .995; NFI = .993; RMSEA= .03 (90 % CI = .01-.06; PClose = .83 for women with none or one prior birth (para 0-1), and (χ^2 (3) = 7.101, p = .069; CMIN/df ratio = 2.37; CFI = .992; NFI = .986; RMSEA = .05 (90 % CI = .00-.09; PClose = .45) for those with more than 2 prior births (para 2+). The model had full metric invariance and partial scalar invariance across these groups after removing the equality constraints on the intercepts of pregnancy-specific distress, life events distress, and number of major life events. Para 0-1 women reported significantly higher state anxiety and pregnancy-specific distress, and lower perceived stress, life events distress with less major life events than para 2+ women. However, para 2+ women on average had significantly higher levels of PNMS than para 0-1 women (M = .057, SE = .027, CR = 2.106, $p < .05$).

Gravidity (gravida 0-2 vs. 3+). The model had good fit in both subgroups, χ^2 (3) = 10.614, p = .014; CMIN/df ratio = 3.54; CFI = .994; NFI = .991; RMSEA = .04 (90 % CI= .01-.07; PClose = .72) for women with 0-2 prior pregnancies, and χ^2 (3) = 4.95, p = .176; CMIN/df ratio = 1.65; CFI = .998; NFI = .994; RMSEA= .02 (90 % CI = .00-.06; PClose = .83) for women with more than 3 prior pregnancies. The model had full metric and partial invariance across these groups after allowing the intercepts of pregnancy-specific distress and number of major life events to vary across the groups. Gravida 0-2 women scored significantly higher on pregnancy-specific distress, lower on perceived stress, number of major life events, and life events distress than gravida 3+ women. Latent mean comparisons indicated that women with more than 3 prior pregnancies on average had significantly higher PNMS compared to those with

0-2 prior pregnancy experiences (*M* = .054, SE = .023, CR = 2.336, $p < .05$).

In conclusion, the hypothesized model was a good fit to the data, and partially invariant across women of various backgrounds in age, ethnicity, education, marital status, income, employment status, pregnancy-intendedness, parity, and gravidity. Younger, single, unemployed, less educated women with less income, those with an unintended pregnancy, and those with more pregnancy and birth experiences were more likely to report higher PNMS relative to their comparison groups.

Discussion

The present study tested the validity of a multivariate conceptualization and measurement model of PNMS across women diverse in age, ethnicity, education, marital status, income, employment status, pregnancy intendedness, parity, and gravidity. As hypothesized, the multivariate model of PNMS fit well to the data and had measurement invariance across these groups.

The support for configural invariance confirmed that the factor structure of the latent variable of PNMS was the same across the groups. The baseline model established for each group separately had good fit for all groups in simultaneous CFA analyses, indicating that the structure of factor loadings was the same across groups. That is, it appears that the construct of PNMS can be conceptualized and operationalized in the same way across these different groups of women.

The model had full metric invariance across age, ethnicity, employment status, parity, and gravidity, and partial metric invariance across education, marital status, income, and pregnancy intendedness. The evidence for (full or partial) metric invariance revealed that different groups respond to the observed measures of stress (i.e., state anxiety, pregnancy-specific distress, number of major life events, life events distress, and perceived stress) in the same way, confirming the construct validity of the model across groups.

According to Byrne (1989), even if full metric invariance is not achieved, evidence for partial scalar invariance is sufficient to conduct legitimate group comparisons of the observed and latent means, provided that at least two items per factor in the model exhibit invariance (Byrne et al., 1989). It should be noted that partial invariance is acceptable in analyses of latent variable models. When multivariate models are used and analyses involve aggregating single items to a composite score without using MGCFA, partial invariance is not sufficient. MGCFA allows estimating intercepts, loadings, and latent means as well as analyzing group differences in each of these parameters. However, in composite analyses, observed and latent means are implicitly equated as it is impossible to separate intercepts, loadings, and latent means. Because even one unequal intercept can have a substantial impact on the composite score, full scalar invariance is required for legitimate group comparisons on observed and latent means (Steinmetz, Schmidt, Tina-Booh, Wieczorek, & Schwartz, 2009). Since the analyses in the current study involved a latent variable model, achieving partial scalar invariance was sufficient for legitimate comparisons across groups. Significant latent mean differences across groups underscored the possibility that pregnancy may be more stressful for younger, single, unemployed, less educated women with less income, women with an unintended pregnancy, and those with more pregnancy and birth experiences relative to their comparison groups. These findings suggest that individual-level variables help to explain why pregnancy is particularly stressful for some women. Inclusion of individual-level variables as potential risk factors for adverse birth outcomes in prospective designs may better help researchers to understand prenatal stress and its health effects.

It is also important to note that the present study conceptualized and modeled PNMS as a first-order latent variable with five observed variables. Partial invariance was achieved for the model across each variable by removing equality constraints on factor loadings and/or intercepts of observed variables. The first order structure of the latent model did not allow testing for measurement invariance at the item-level for each observed variable. It would be very useful if future studies tested the same multivariate model as a second-order latent variable, and explored item-level differences when full invariance is not achieved. This might help to identify whether specific items of various stress measures are equally appropriate or not across groups of women, and could enable refinement of those measures for more informative and accurate multigroup comparisons.

The present study employed a multivariate approach to define and measure PNMS, and confirmed the validity of this approach for multigroup comparisons in a large, population-based sample. However, the study findings should be evaluated along with study limitations. First, participants in the present study were asked to report their pregnancy-related experiences retrospectively. Although data were collected within the first 3 to 6 months following the delivery to minimize recall biases, they may still be vulnerable to recall biases as participants' recollections of their experiences during pregnancy may not be accurate. Moreover, stress appraisals and emotional responses reported by participants may have been influenced by their state or mood at the time of assessment. Second, the study had a large sample size with greater power to find systematic differences (in means or intercepts). It is well-documented that the power of the Chi-square test to detect misspecifications in structural equation modeling depends on characteristics of the model and the sample size (Saris, Satorra, & van der Veld, 2009). In the context of measurement invariance, this might result in statistically significant yet spurious group differences (Steinmetz, 2009). The problem of Type II error in measurement invariance testing was minimized in the present study by using ΔCFI tests (in addition to ΔChi Square tests) which are insensitive to sample size. However, future studies examining measurement invariance with large sample sizes might consider using cross-validation to ensure that results are not driven by the study sample size and power. Finally, a majority of the groups compared in the study had unequal sample sizes which might have increased the probability of Type II error in MGCFA (Kaplan & George, 1995). To minimize this error, median splits were used to determine group membership for continuous grouping variables (e.g., age, parity, and gravidity). Because the study had a population-based, representative sample, unequal sample sizes in groups were thought to be an accurate representation of the distribution of group membership in the study population for categorical grouping variables (e.g., ethnicity, education, and marital status). Whenever possible, robustness of measurement invariance across groups was also confirmed by using different subgroups for categorical variables (e.g., White vs. Non-White, including only African-Americans in the second category), and the same patterns of results were obtained.

In conclusion, the study findings suggest that multivariate approaches to PNMS are valid for multigroup comparisons, and can be particularly useful in population-based studies to uncover real differences in degrees and types of stress for pregnant women of various backgrounds. These approaches may also help us better understand the biopsychosocial mechanisms involved in the effects of prenatal stress on birth outcomes and facilitate the successful development of prevention and intervention programs.

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Table 1.1

Participant Characteristics (N = 2709)

	% (N) or Mean ± SD
Age at delivery	28.32 ± 5.45
Parity	0.86 ± 1.01
Gravidity	2.39 ± 1.46
Ethnicity	
White	88.4 % (2394)
Black	5.1 % (139)
Asian or Pacific Islander	3.4 % (93)
Mixed race	3.1 % (83)
Education	
<= High school	19.8 % (536)
Some college, associate degree or vocational school	32.5 % (880)
College graduate (BA)	33.1 % (898)
Graduate or professional school	14.6 % (395)
Marital status	
Married or cohabitating as if married	86.9 % (2355)
Single	10.3 % (279)
Missing	2.8 % (75)
Annual income*	Range: $0 - 800,000 Median: $ 60,000
Poor	17.4 % (471)
Near poor to low income	15.6 % (423)
Moderate income	31.7 % (859)
High income	35.3 % (956)
Employment status during pregnancy	
Employed	79 % (2134)
Unemployed	21 % (575)
Pregnancy intendedness of participants	
Intended	57.7 % (1564)
Unintended	42.3 % (1145)

* An income-poverty ratio (IPR) was calculated by dividing participants' annual household income by the number of people living with them. The following cut-off scores were used to determine income groups: *Poor* if IPR <1.0; *near poor to low income* if IPR = > 1.0 and < 2.0; *moderate income* if IPR= > 2.0 and < 4.0; *high income* if IPR = > 4.

Table 1.2

Descriptive Statistics For Prenatal Maternal Stress Measures

Prenatal maternal stress measures	*M*	*SD*	*Std. Error*	*Min-Max*
Prenatal state anxiety	13.24	3.45	0.66	2-25
Pregnancy-specific distress	29.25	7.80	0.15	17-64
Prenatal perceived stress	12.59	1.65	0.03	6-20
Number of prenatal life events	3.03	2.93	0.06	0-19
Life event distress ratings	1.40	1.03	0.02	0-3

*Calculations were based on raw scores.

Table 1.3

Correlations Among Study Variables

	Correlation Coefficients								
Variables	Pregnancy Specific Distress	State Anxiety	Perceived Stress	Number of Life Events	Life Events Distress	Maternal Age	Income	Parity	Gravidity
Pregnancy Specific Distress	-	.32**	.08**	.34**	28**	-.16**	-.13**	-.19**	-.13**
State Anxiety		-	.12**	.11**	.13**	-.04*	-.03	-.10**	-.04*
Perceived Stress			-	.09**	.10**	.02	-.02	.02	.04*
Number of Life Events				-	.62**	-.25**	-.30**	.06**	.08**
Life Events Distress					-	-.09**	-.15**	.07**	.09**
Maternal age						-	.40**	.28**	.31**
Income							-	-.03	-.01
Parity								-	.81**
Gravidity									-

$*p < .05$, $**p < .01$

Table 1.4

Descriptive Statistics for Subsamples Tested for Measurement Model Invariance

Variables	*N *(%)*
Age at delivery	18-28 years vs. 29+ years
	1421 (*52.5%*) vs. 1288 (*47.5%*)
Ethnicity	White vs. Non-White
	2394 (*88.4%*) vs. 315 (*11.6 %*)
Education	≤ High school vs. > High school
	536 (*19.8 %*) vs. 2173 (*80.2%*)
Marital status	Single vs. Married
	279 (*10.6 %*) vs. 2355 (89.*4%*)
Annual income	Poor-to-low vs. Moderate-to-high income
	894 (*33%*) vs. 1815 (*67%*)
Employment status during pregnancy	Employed vs. Unemployed
	2134 (*79.7%*) vs. 543 (20.3%)
Pregnancy intendedness of women	Intended vs. Unintended
	1562 (57.7%) vs. 1145 (42.3%)
Parity	Para 0-1 vs. 2+
	2113 (*78%*) vs. 596 (*22%*)
Gravidity	Gravida 0-2 vs. 3+
	1673 (*61.8%*) vs. 1036 (*38.2%*)

*Total number of participants for some grouping variables might not be equal to the total study sample size due to missing values.

Table 1.5

Goodness of Fit Statistics for Tests of Multigroup Measurement Invariance

Variable	Model	χ^2	df	$\Delta\chi^2$	Δ df	CFI	Δ CFI	Model Comparison	Decision
Age at delivery	1.Configural invariance	17.695	6	-.	-	0.994	-	-	-
	2.Metric invariance	35.704	10	18.009	4	0.987	0.007	1 vs. 2	Invariant
	3.Full scalar invariance	192.477	15	156.773	5	0.911	0.076	2 vs. 3	Non-invariant
	4.Partial scalar invariance	44.194	12	148.283	2	0.984	0.003	2 vs. 4	Invariant
Ethnicity	1.Configural invariance	18.268	8	-		0.995	-	-	-
	2.Metric invariance	31.785	12	13.517	4	0.990	0.005	1 vs. 2	Invariant
	3.Full scalar invariance	96.126	17	64.341	5	0.960	0.030	2 vs. 3	Non-invariant
	4.Partial scalar invariance	45.036	15	13.251	2	0.985	0.005	2 vs. 4	Invariant
Education	1.Configural invariance	26.066	8	-		0.991	-	-	-
	2.Metric invariance	58.938	12	32.872	4	0.976	0.015	1 vs. 2	Non-invariant
	3.Partial metric invariance	44.638	9	18.572	1	0.982	0.009	1 vs. 3	Invariant
	4.Full scalar invariance	229.489	17	184.851	8	0.891	0.091	3 vs. 4	Non-invariant
	5.Partial scalar invariance	46.475	11	1.837	2	0.982	0.000	3 vs. 5	Invariant
Marital status	1.Configural invariance	19.673	6	-		0.992	-	-	-
	2.Metric invariance	58.642	10	38.969	4	0.973	0.019	1 vs. 2	Non-invariant
	3.Partial metric invariance	43.015	8	23.342	2	0.982	0.010	1 vs. 3	Invariant
	4.Full scalar invariance	312.589	15	269.574	7	0.834	0.148	3 vs. 4	Non-invariant
	5.Partial scalar invariance	43.459	10	0.444	2	0.981	0.001	3 vs. 5	Invariant

Table 1.5 (cont'd)

Goodness of Fit Statistics for Tests of Multigroup Measurement Invariance

Variable	Model	χ^2	df	$\Delta\chi^2$	Δ df	CFI	Δ CFI	Model Comparison	Decision
Income	1.Configural invariance	18.127	6	-		0.994	-	-	-
	2.Metric invariance	59.125	10	40.998	4	0.974	0.020	1 vs. 2	Non-invariant
	3.Partial metric invariance	34.045	8	15.918	2	0.986	0.008	1 vs. 3	Invariant
	4.Full scalar invariance	431.574	15	397.529	7	0.778	0.208	3 vs. 4	Non-invariant
	5.Partial scalar invariance	37.336	10	3.291	2	0.985	0.001	3 vs. 5	Invariant
Employment	1.Configural invariance	18.046	6	-		0.994	-	-	-
	2.Metric invariance	27.663	10	9.617	4	0.991	0.003	1 vs. 2	Invariant
	3.Full scalar invariance	68.845	15	41.182	5	0.973	0.021	2 vs. 3	Non-invariant
	4.Partial scalar invariance	45.902	14	18.239	4	0.984	0.007	2 vs. 4	Invariant
Pregnancy	1.Configural invariance	10.954	6	-		0.994	-	-	-
Intendedness	2.Metric invariance	47.014	10	36.06	4	0.981	0.013	1 vs. 2	Non-invariant
	3. Partial metric invariance	23.313	7	12.359	1	0.992	0.002	1 vs. 3	Invariant
	4.Full scalar invariance	345.979	15	322.666	8	0.831	0.161	3 vs. 4	Non-invariant
	5.Partial scalar invariance	24.769	8	1.456	1	0.991	0.001	3 vs. 5	Invariant
Parity	1.Configural invariance	17.715	6	-		0.993	-	-	-
	2.Metric invariance	22.872	10	5.157	4	0.992	0.001	1 vs. 2	Invariant
	3.Full scalar invariance	123.238	15	100.366	5	0.936	0.056	2 vs. 3	Non-invariant
	4.Partial scalar invariance	37.65	12	14.778	2	0.985	0.007	2 vs. 4	Invariant

Table 1.5 (cont'd)

Goodness of Fit Statistics for Tests of Multigroup Measurement Invariance

Variable	Model	χ^2	df	$\Delta\ \chi^2$	Δ df	CFI	Δ CFI	Model Comparison	Decision
Gravidity	1.Configural invariance	15.564	6	-		0.995	-	-	-
	2.Metric invariance	21.442	10	5.878	4	0.994	0.001	1 vs. 2	Invariant
	3.Full scalar invariance	105.536	15	84.094	5	0.955	0.039	2 vs. 3	Non-invariant
	4.Partial scalar invariance	42.174	13	20.732	3	0.986	0.008	2 vs. 4	Invariant

Table 1.6

Group Differences in Observed Variables

	State Anxiety			Pregnancy Specific Distress			Perceived Stress			Number of Major Life Events			Life Events Distress		
Groups	M	*SD*	p-value	M	*SD*	p-value	M	*SD*	p-value	M	*SD*	p-value	M	*SD*	p-value
Age															
Younger	13.38	*3.62*	**<.05**	1.47	*0.11*	**<.001**	12.54	*1.75*	0.12	1.66	*0.92*	**<.001**	1.48	*0.99*	**<.001**
Older	13.08	*3.23*		1.44	*0.1*		12.64	*1.54*		1.27	*0.88*		1.3	*1.07*	
Ethnicity															
White	13.27	*3.39*	0.12	1.45	*0.11*	**<.05**	12.58	*1.62*	0.62	1.43	*0.91*	**<.001**	1.37	*1.03*	**<.001**
Non-White	12.72	*3.97*		1.48	*0.14*		12.68	*2.19*		2.01	*0.88*		1.75	*0.97*	
Education															
=< High school	13.21	*4.07*	0.84	1.47	*0.13*	**<.001**	12.49	*2.05*	0.18	1.92	*0.86*	**<.001**	1.69	*0.94*	**<.001**
> High school	13.24	*3.27*		1.45	*0.1*		12.61	*1.54*		1.36	*0.9*		1.32	*1.04*	
Marital status															
Single	13.36	*4.04*	**<.001**	1.5	*0.13*	0.52	12.59	*2.01*	0.94	2.28	*0.8*	**<.001**	1.93	*0.81*	**<.001**
Married	13.2	*3.35*		1.44	*0.11*		12.58	*1.6*		1.35	*0.87*		1.31	*1.04*	
Income															
Poor-to-low	13.28	*3.89*	0.67	1.47	*0.12*	**<.001**	12.67	*1.85*	0.07	1.96	*0.88*	**<.001**	1.69	*0.93*	**<.001**
Moderate-to-high	13.22	*3.2*		1.44	*0.1*		12.55	*1.55*		1.24	*0.85*		1.25	*1.04*	

Table 1.6 (cont'd)

Group Differences in Observed Variables

	State Anxiety			Pregnancy Specific Distress			Perceived Stress			Number of Major Life Events			Life Events Distress		
Groups	M	*SD*	p-value	M	*SD*	p-value	M	*SD*	p-value	M	*SD*	p-value	M	*SD*	p-value
Employment															
Unemployed	13.24	*3.39*	0.49	1.45	*0.11*	**<.05**	12.56	*1.59*	0.17	1.43	*0.91*	**<.001**	1.47	*1.03*	**<.05**
Employed	13.12	*3.66*		1.44	*0.12*		12.68	*1.89*		1.65	*0.94*		1.49	*1.01*	
Pregnancy intendedness															
Intended	13.32	*3.29*	0.16	1.43	0.1	**<.001**	12.55	1.56	0.23	1.24	0.86	**<.001**	1.28	1.06	**<.001**
Unintended	13.12	*3.65*		1.47	0.12		12.63	1.77		1.79	0.9		1.55	0.96	
Parity															
0-1	13.34	*3.38*	**<.05**	1.46	0.11	**<.001**	12.55	1.62	**<.05**	1.45	0.91	**<.01**	1.36	1.02	**<.01**
2+	12.86	*3.65*		1.42	0.11		12.71	1.76		1.56	0.95		1.5	1.05	
Gravidity															
0-2	13.33	*3.32*	0.07	1.46	0.11	**<.001**	12.53	1.62	**<.05**	1.44	0.91	**<.01**	1.34	1.02	**<.01**
3+	13.08	*3.63*		1.43	0.11		12.68	1.7		1.54	0.93		1.48	1.04	

Table 1.7

Group Differences in Latent Mean of PNMS

Variables	M	SE	C.R.	*p*
Age: 18-28 vs. 29+ years*	.192	.036	5.250	<.001
Ethnicity: White* vs. Non-White	.218	.046	4.764	<.001
Education: ≤ High school vs. ≥ High school*	.280	.052	5.420	<.001
Marital status: Single vs. Married*	.401	.083	4.845	<.05
Income: Poor-to-low vs. moderate-to-high*	.295	.058	5.096	<.001
Employment: Unemployed vs. Employed*	.106	.031	3.438	<.001
Pregnancy intendedness: Intended* vs. Unintended	.239	..046	5.177	<.001
Parity: 0-1* vs. 2+	.057	.027	2.106	<.05
Gravidity: 0-2* vs. 3+	.054	.023	2.336	<.05

Reference group in each comparison is shown with an asterisk. M = Mean, SE= Standard Error, C.R. = Critical ratio

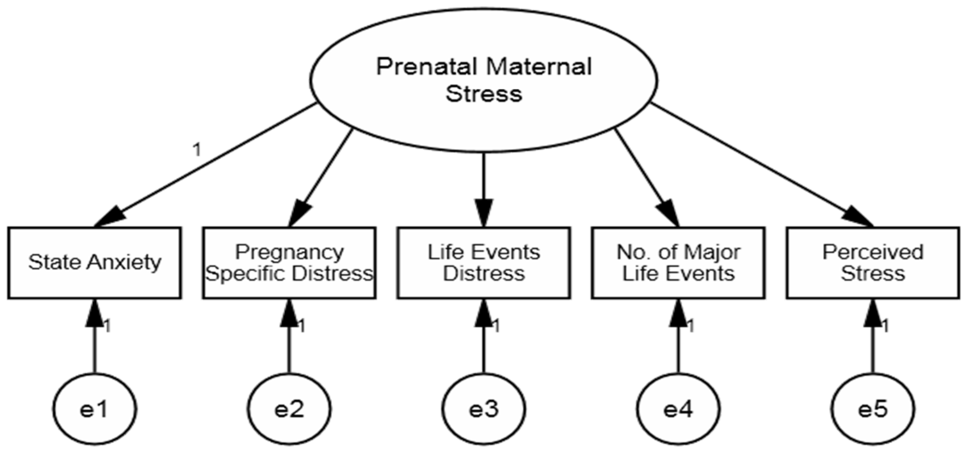

Figure 1.1. Hypothesized measurement model for the latent variable, prenatal maternal stress. Prenatal maternal stress is represented by state anxiety, pregnancy-specific distress, life events distress, number of major life events, and perceived stress.

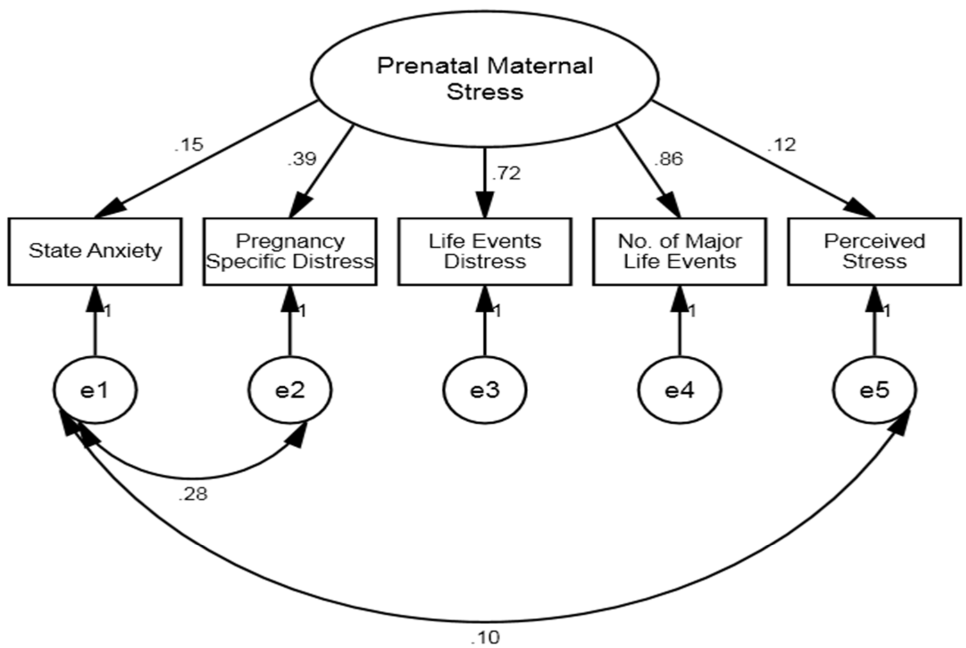

Figure 1.2. Modified measurement model for the latent variable, prenatal maternal stress with its standardized estimates. All factor loadings are statistically significant ($p < .001$). The model given above is also the baseline model tested in all multigroup invariance tests.

Identifying Patterns of Intimate Partner Violence Prior to, During, and After Pregnancy: A Latent Transition Analysis

Intimate partner violence (IPV) against women is a serious global health problem and a human rights abuse with direct and indirect effects on women's physical, mental, sexual and reproductive health (Campbell, 2002; Ellsberg, Jansen, Heise, Watts, Garcia-Moreno, 2008; Heise, 1996). IPV against women first received national attention in the United States in the late 1960s with the rise of the women's rights movement (Watts & Zimmerman, 2002). However, systematic research on IPV against women did not start until the mid-1970s (Straus & Gelles, 1995) and since then, reported prevalence rates have been highly inconsistent (McHugh & Frieze, 2006). Estimating abuse prevalence is particularly difficult due to the private nature of abuse, and estimates vary according to the population studied, the time and method of screening, and different operational definitions utilized (Coker, Sanderson, & Dong, 2004). A large-scale study carried out by the World Health Organization in 15 sites in 10 countries found that lifetime prevalence of IPV against women ranges from 15% to 71% (Garcia-Moreno, Jansen, Ellsberg, Heise, & Watts, 2006). The estimated prevalence of IPV against women at any time for developed countries ranges from 9.7% to 29.7% (Gazmararian, Lazorick, Spitz, Ballard, Saltzman, & Marks, 1996). In the United States, approximately one in four women reports IPV at some point during her lifetime with substantial negative health consequences (Black et al., 2011). According to national surveys, 25-30% of women in the United States report physical and/or sexual abuse by an intimate partner during their lifetime (e.g., Breiding, Black, & Ryan, 2008; Tjaden & Thoennes, 1998), whereas clinical studies report lifetime prevalence estimates of physical, sexual, and/or emotional abuse against women ranging from 21-55% (e.g., Coker, Smith, McKeown, & King, 2000).

IPV against women may be a particularly serious problem when experienced during pregnancy. Poor health, preterm delivery, low birth weight, small size for gestational age, surgical delivery, kidney infections, maternal mortality and infant mortality are more likely to occur among abused pregnant women than non-abused pregnant women (e.g., Alhusen, Lucea, Bullock, & Sharps, 2013; Boy & Salihu, 2004; Coker, et al., 2004; Leone et al., 2010; Saito, Creedy, Cooke, & Chaboyer, 2013). However, only recently have studies begun to focus on the prevalence and effects of IPV preceding, during, and following an index pregnancy. Within the existing literature, reported prevalence estimates are inconsistent (Glander, Moore, Michielutte, & Parsons, 1998; Waltermaurer, 2005). A review of 13 studies by Gazmararian and colleagues (1996) documented that the prevalence of IPV during pregnancy ranged from 0.9% to 20.1%. The Centers for Disease Control and Prevention (CDC) reported population-based estimates from 13 states for domestic violence during pregnancy ranging from 2.4% to 5.6% (Gilbert, Johnson, Morrow, Gaffield, & Ahluwalia, 1997). More recent studies indicate that two in five women report experiencing violence during pregnancy (Silverman, Decker, Reed, & Raj, 2006a). The wide-ranging, substantially differing prevalence estimates reported for pregnancy-related violence are attributable to differences in samples, methodologies, definitions of IPV, and measures used (Gazmararian, Petersen, Spitz, Goodwin, Saltzman, & Marks, 2000; Jasinski, 2004).

Although IPV may affect any woman, those experiencing abuse during pregnancy are younger, of lower SES (less than a high school education and earning below the poverty line) and higher parity, and more likely to be single, receive Medicaid, report more stressful life events during pregnancy, report unintended pregnancy, have insufficient prenatal care, and a history of childhood abuse (e.g., Bourassa & Bérubé, 2007; Cokkinides & Coker, 1998;

Gazmararian et al., 1996; Glander et al., 1998; Goodwin, Gazmararian, Johnson, Gilbert et al., 1997; Gilbert, Saltzman, & Group, 2000). There is also some evidence that IPV is associated with race and ethnicity, although results are inconsistent (Charles & Perreira, 2007). Some studies report no difference between racial groups (e.g., Wiemann, Agurcia, Berenson, Volk, & Rickert, 2000); others indicate higher rates of IPV among white than non-White women before, during, or after pregnancy (e.g., McFarlane, Parker, Soeken & Bullock, 1992). Moreover, drinking, smoking, using illicit drugs, having a partner using drugs or alcohol, seeking induced abortion without partner involvement, and diagnosis of sexually transmitted diseases are also correlates of IPV surrounding pregnancy (Berenson, Stiglich, Wilkinson, & Anderson; 1991; Campbell, Poland, Waller, & Ager, 1992; Dietz, Gazmararian, Goodwin, Bruce, Johnson, & Rochat, 1997; Gazmararian et al., 1995; Glander et al., 1998).

Previous research on IPV during pregnancy has mainly focused on its consequences for birth outcomes (Cokkinides, Coker, Sanderson, Addy, & Bethea, 1999; Moraes, Amorim, & Reichenheim, 2006; Morland, Leskin, Block, Campbell, & Friedman, 2008; Shumway, O'Campo, Gielen, Witter, Khouzami, Blakemore, 1999), but there is little research examining motives and risk factors for pregnancy-related violence (Jasinski, 2004). Whether pregnant women experience a different level of risk for IPV compared to non-pregnant women and whether the severity and type of violence against women changes before, during, and after pregnancy have yet to be determined conclusively (Charles & Perreira, 2007; Jasinski, 2001; Rachana, Suraiya, Hisham, Abdulaziz, & Hai, 2002). Thus, researchers and clinicians lack sufficient information about pregnancy-related violence for effective analysis, intervention, and prevention

Changes in IPV Across Pre-Pregnancy, Pregnancy, and Postpartum

Prior research on IPV within the context of pregnancy has focused heavily on determining the prevalence of IPV, and largely ignored the question of whether and how the frequency and type of abuse change across pre-pregnancy, pregnancy, and postpartum. The most commonly reported prevalence estimates for abuse during the year prior to pregnancy range from 4% to 26% (e.g., Cokkinides et al., 1999; Gazmararian et al., 1995; Helton, McFarlane, Anderson, 1987; Stewart & Cecutti, 1993), whereas estimates for the postpartum period, typically defined as 3 to 6 months or 12 months after birth, range from 3% to 24% (Hedin, 2000; Martin, Mackie, Kupper, Buescher, & Moracco, 2001).

With respect to comparisons of the pre-pregnancy and prenatal periods, existing data are mixed; some studies suggest that the frequency of abuse may increase during pregnancy relative to pre-pregnancy (e.g., Burch & Gallup, 2004), while others report a decrease in abuse during pregnancy (e.g., Martin et al., 2001; Saltzman, Johnson, Gilbert, & Goodwin, 2003). The second National Family Violence Survey reported a substantially higher rate of physical violence against women during the year prior to pregnancy than during pregnancy. However, after adjusting for the effects of age, this difference disappeared (Gelles, 1988). Ballard et al., (1998) reviewed three studies: Two reported that 86 to 88% of women who were abused during pregnancy were also abused three months prior to the pregnancy (Helton et al., 1987; Stewart & Cecutti, 1993); the third study reported that 12% of women abused prior to pregnancy continued to be abused prenatally (Amaro, Fried, Cabral, & Zuckerman, 1990). Moreover, review of the studies by Stewart and Cecutti and by Helton et al. indicated that 12 to 14% of women reported experiencing violence during, but not prior to, their pregnancy (Ballard et al., 1998).

Studies on the prevalence of postpartum abuse by an intimate partner are also limited in number, and vary substantially in the samples used, methods employed, and definition of postpartum period. For instance, in a cross-sectional study using a statewide sample from the North Carolina Pregnancy Risk Assessment Monitoring System (PRAMS), the prevalence of abuse before and during pregnancy was 6.9% and 6.1% respectively, whereas the prevalence of postpartum abuse was 3.2% (Martin et al., 2001). The pre-pregnancy and postpartum period were defined as 12 months prior to and after pregnancy respectively and only physical abuse was assessed. In contrast, in a clinic-based longitudinal study where 275 women were interviewed 3 times during pregnancy and at 6 months postpartum to assess severity and frequency of partner abuse, 19% reported moderate or severe violence by their partners prenatally and 25% reported this during the postpartum period (Gielen, O'Campo, Faden, Kass, & Xue, 1994).

The months following delivery are particularly stressful due to the challenges of taking care of a newborn (Graham, Lobel, & DeLuca, 2002), especially for those with limited resources, and therefore, may be a particularly high-risk period for IPV (Charles & Perreira, 2007; Shoffner, 2008). There is some evidence that previous abuse (before and/or during pregnancy) predicts postpartum abuse. In a nationally representative cohort of pregnant women in 20 U.S. cities, prenatal abuse was the strongest predictor of abuse one-year postpartum (Charles & Perreira, 2007). Similarly, in a study carried out with Swedish women attending prenatal clinics, 90% of women who were abused during their pregnancy also reported experiencing abuse during the three-month period following delivery (Hedin, 2000).

Due to the lack of longitudinal, population-based studies examining the frequency and type of abuse before, during, and after an index pregnancy, current knowledge is too limited to indicate whether the frequency and intensity of IPV increases, decreases, or remains constant from the period preceding pregnancy to the prenatal period, or whether the type of abuse changes across the pre-pregnancy, pregnancy, and postpartum periods.

Prenatal care is one of the rare windows of opportunity for identifying women abused during pregnancy. For many women with limited resources, prenatal care appointments are the only contact point with health care providers (Devries et al., 2010). Therefore, knowing the prevalence, correlates, and patterns of IPV prior to, during and after pregnancy is the first step in helping to inform violence screening programs in health care clinics. Knowing correlates and risk factors for IPV surrounding pregnancy may not provide specific information as to how to intervene in prenatal violence, but may help researchers and health care practitioners identify vulnerable groups to target for IPV prevention.

A Variable-Centered or a Person-Centered Approach to IPV?

The CDC defines the term *intimate partner violence* as ‘physical, sexual or psychological harm or threats by a current or former partner or spouse,’ and asserts that IPV should be defined on a continuum (Saltzman, Fanslow, McMahon & Shelley, 2002). This definition implies that intimate partner violence may take various forms and may be experienced in different ways by each woman, emphasizing the heterogeneity of IPV experiences. Defining IPV on a continuum also necessitates examining the stability and change in occurrences of different types of IPV across time *within* a relationship. Temporal stability of IPV has been shown across a wide range of samples (e.g., O’Leary, Barling, Arias, Rosenbaum, Malone, & Tyree, 1989; O’Leary & Slep, 2003), however, evidence for temporal stability of IPV across pre-pregnancy, pregnancy, and postpartum periods within a relationship has been inconclusive. As a result, our knowledge about whether IPV prior to pregnancy tends to stop during pregnancy or previously non-existing violence is initiated during pregnancy/postpartum period is very limited.

Examining the patterns of IPV, correlates and risk factors for IPV has been challenging to researchers due to the-difficult-to- capture heterogeneity of IPV experiences among women. Therefore, a majority of studies have conceptualized IPV as a unitary construct to examine its health effects by combining different types of IPV to define presence or absence of IPV in general. However, evidence suggests that different types of IPV might be associated with different negative health outcomes (Sutherland, Sullivan, & Bybee, 2001), and placing women who experience physical IPV only into the same group with those who experience both physical and sexual IPV ignores the heterogeneity of IPV experiences. Prior studies defining IPV as a unitary construct have predominantly used a variable-centered approach and corresponding data analytic techniques such as ANOVA and regression which assumes that inter-individual differences are negligible, and focuses on predictors of IPV (Ansara & Hindin, 2010; Bogat, Levendosky, & von Eye, 2005). Working with a unitary construct of IPV may increase the predictive power in detecting health effects of IPV due to increased construct validity achieved by including different types of IPV experiences in a single operational definition of IPV. Furthermore, employing a variable –centered approach and data analytic techniques such as ANOVA and regression allows researchers to identify relations between IPV and associated risk factors in the general population. For instance, variable-centered studies have reported increased risks for IPV among single, unemployed, younger, and poorer women (e.g., Bourassa & Bérubé, 2007; Cokkinides & Coker, 1998; Gazmararian et al., 1996). However, the heterogeneity of IPV experiences within a population is difficult to elucidate using this approach (Bogat et al., 2005). In contrast, a person centered approach, which focuses on uniqueness of IPV experiences, and corresponding data analytic techniques such as latent class analysis and traditional cluster analysis can illuminate individual differences in IPV experience within a population. The central aim of person-centered analyses is to group individuals into classes based on distinctive patterns of shared characteristics (Bogat et al., 2005). Thus, person-centered approaches may be particularly helpful for identifying distinct subtypes or patterns of IPV and their potential effects on health outcomes. Heterogeneity of IPV experiences underscores the necessity of targeted interventions. Person-centered approaches may help designers and implementers of intervention programs identify which groups of women will be most amenable to which type of interventions (Bogat et al., 2005).

The present study employed a predominantly person-centered approach and corresponding data analytic techniques to model change in the pattern of IPV type across the pre-pregnancy, pregnancy, and postpartum periods using latent transition analysis (LTA). It aimed to answer the following questions:

1. Are there distinct subgroups of women within the sample that experience particular patterns in the type of IPV such as only physical IPV, only sexual IPV, or both? Can a model of IPV classes be identified among participants?
2. Is there any change in these particular patterns of IPV across the pre-pregnancy, pregnancy, and postpartum periods? For instance, if a woman experiences physical IPV prior to pregnancy, what is the probability that she will continue to experience physical IPV or no violence or experience sexual IPV during pregnancy and/or the postpartum periods?
3. How does the probability of latent status membership differ by some individual and contextual variables including pregnancy unwantedness of partners, pregnancy intendedness of women, presence of psychological IPV during pregnancy, history of any childhood abuse, and marital status?

Identifying distinct patterns in the type of IPV among women of reproductive age and understanding how these patterns change across pre-pregnancy, pregnancy, and postpartum periods may provide more person-focused guidelines to researchers and clinicians that would help their research and screening efforts targeting IPV.

Method

Participants

Data for the present study were from a larger project examining pregnancy and birth variables in a sample of 2,709 female residents of Black Hawk, Johnson, Polk and Scott counties in Iowa who delivered a live born infant between May 1, 2002 and June 30, 2005. The four Iowa counties were selected for their size, ethnic diversity, the presence of domestic violence referral sources and shelters, and the level of domestic abuse screening activities in local hospitals, clinics and private practices. At least one hospital from each of these selected counties participated in the State of Iowa's Domestic Violence and Health Care Training Project funded by the Family Violence Prevention Fund, San Francisco. This project aimed to train health care providers to identify and respond to victims of domestic violence, and resulted in implementation of routine screening for domestic violence in the prenatal care clinics and emergency departments of the participating hospitals. Therefore, participants recruited from the four counties included in the present study would have been directly asked about domestic violence at least once during their pregnancy. It was predicted that the routine screening for domestic violence in these counties' hospitals would reduce underreporting of domestic abuse by study participants, since repeated screening may help women be more open to disclose their abuse-related experiences (Chen et al., 2007).

Eligible participants were identified from Iowa birth certificate files. Women were included if they: (a) were above the age of 18 at the time of delivery, (b) spoke English, (c) did not have Type 1 or Type 2 diabetes mellitus, systemic lupus, or chronic renal disease, or (d) a multiple birth. The latter two eligibility criteria were established because of the goals of the larger project of which the present study was part. Because Iowa law mandates reporting of domestic abuse of a minor woman by a parent, legal guardian or caretaker to legal authorities, the study was unable to ensure complete confidentiality to those women. Therefore, the study sample was restricted to women of legal age.

As shown in Table 2.1, the sample was predominantly White (88.4%), married (86.9 %) with an average age of 28.32 years (*SD* = 5.45). A majority of women reported having more than a high school education (80.2%) with moderate-to-high income (67%). Approximately 58% of women reported that their pregnancies were intended, and 8.3% of these women were in infertility treatment before they became pregnant.

Procedure

Participant recruitment. Only name and address information of eligible participants were obtained from the birth certificate files. Letters of invitation were then sent to the address listed on the birth certificate for each eligible participant. The introductory letter informed potential participants about their eligibility to participate in the study determined through birth certificates. The study was described as consisting of a one-hour telephone interview which would cover medical and reproductive history, health behaviors and stress during pregnancy, and how couples overcome disagreements in their intimate relationships. Compensation of $30 was offered for participation to be paid upon completion of the interview. A toll free number for the project was provided in the letter so that women who wanted to participate, but preferred not to be contacted at home, or women whose phone numbers changed, could call to arrange an interview or ask questions.

Eligible participants were recruited into the study two weeks after the introductory letter by trained interviewers. With the help of multiple resources including the Iowa Birth Defects Registry, home telephone numbers were found and telephone contacts were attempted within 3 to 6 months following delivery. A special contact protocol was created to be followed by interviewers. Accordingly, at least one contact (defined as a direct conversation, message left, or no response) was required during each of four time periods over a 48-hour period. If the interviewer was not able to introduce the study at the end of the 48-hour contact protocol, then a first “recruitment letter” was sent to remind the eligible participant of the study and to let her know that an interviewer would attempt to reach her again in the following week. If phone contact with the eligible participant was not accomplished again, then a second “recruitment letter” was sent and the contact protocol given above was repeated. If a third attempt was unsuccessful, then a “no contact” letter was sent asking the eligible participant to suggest times for the interview or to decline to participate in the study.

Of the 7,202 potential respondents identified from birth certificates, 4,250 (59 %) women were reached by telephone. Of these, 12.9 % (*N* =548) were ineligible for participation based on the study exclusion criteria. Over 77 % (*N* =2,866) of the 3,702 eligible women agreed to participate, and of these, 94.5 % (*N* =2,709) completed the computer-assisted telephone interview.

Computer-assisted telephone interviews (CATIs). Data were collected by CATIs between August 2002 and January 2006. The telephone interviewing method was specifically chosen for its potential of eliciting higher and more accurate responses relating to intimate partner violence than face-to-face interviewing due to increased anonymity and confidentiality. All interviews were conducted by trained, experienced female interviewers. After completion of the interviews, participants were offered information on local and statewide intimate partner violence resources that provide counseling and shelter. This information was given over the telephone unless participants asked it to be mailed without any safety concerns.

Measures

Demographic characteristics. Participants reported their age at delivery (in years), ethnicity (coded as White, Black, Asian or Pacific Islander, or mixed race), level of education (coded as high school equivalent or less, some college, associate degree or vocational school, college graduate, or graduate/professional school), marital status (coded as married or single), annual household income (reported in dollars, recoded as poor, near poor to low income, moderate income, or high income based on an income-poverty ratio calculated by dividing participants' annual household income by number of people living in their household), employment status during pregnancy (coded as unemployed or employed), pregnancy intendedness of participants (coded as intended or unintended), pregnancy unwantedness of partners (coded as yes, no), parity and gravidity (numerical values), and biological relations of current partner to delivered baby (father: yes, no). Pregnancy intendedness of women was assessed by asking them (1) whether they wanted to be pregnant at that time or sooner; or later; or did not want to be pregnant then or at any time in the future, (2) whether they felt excited about having the baby once they found out that they were pregnant. Those who wanted to be pregnant later or did want pregnancy then or at any time in the future and those who did not report being excited about having the baby were coded as women with an unintended pregnancy. Women were also asked whether her partner said that he did not want her to be pregnant at any time during the 12 months before delivery. A yes response to this question was coded as an indicator of pregnancy unwantedness of the partner.

Psychological IPV. The 10-item Women's Experiences with Battering scale (WEB; Smith, Earp, & DeVellis, 1995) with six filler items was used to screen participants for IPV. The WEB was used as a screening tool because it conceptualizes IPV as a *continuous process* rather than *a discrete event*, and measures the experiences of women in abusive relationships rather than the behaviors of their abusive partners. The WEB focuses on the enduring nature of violence and victimization, and assesses women's perceptions of their vulnerability to physical danger and their sense of loss of power and control in their intimate relationships. Prior research has shown that the WEB is a more sensitive and comprehensive screening tool for identifying IPV compared to many other validated tools that focus primarily on physical assault (Coker, Pope, Smith, Sanderson, & Hussey, 2001; Smith et al., 1995). Participants were asked to indicate how much they agree or disagree with items describing their relationship during their pregnancy on a 6 point-scale ranging from "strongly disagree" (1) to "strongly agree" (6). Sample items included "He made me feel unsafe, even in my home," and "I tried not to rock the boat because I was afraid of what he might do." A total WEB score was calculated for each participant by summing item responses. The scale was internally consistent, Cronbach's $\alpha = 0.93$. A score of 20 points or higher on the WEB is considered positive for psychological IPV during pregnancy (Smith et al., 1995).

Physical abuse. Physical IPV was assessed by a modified version of the 3-item Abuse Assessment Screen (AAS; McFarlane & Parker, 1994). The AAS was developed for routine screening of prenatal care patients by the Nursing Research Consortium on Violence and Abuse and incorporated by the March of Dimes into their Protocol for Prevention and Intervention of

Abuse during Pregnancy (McFarlane, Parker, & Cross, 2001). The AAS includes three questions. The first question asks participants if they have been “hit, slapped, kicked or otherwise physically hurt by someone” in the past year. If participants answer ‘yes’, then they are asked to indicate who hurt them and how many times this happened. The second question is the same as the first one, except that it focuses on the period of pregnancy instead of the past year. The third question asks participants to indicate if anyone has forced them into sexual activities in the last year. The modified version used in the present study examined physical abuse during three specific periods (i.e., six month preceding the pregnancy, the pregnancy period, and the 3-6 months of time since the baby was born). Presence or absence of physical abuse was coded dichotomously (yes/no).

The AAS was used in the present study for several reasons. First, it is a brief measure which is highly correlated with more elaborate instruments (McFarlane et al., 1992). Second, it enables participants to report abuse perpetrated by people other than their partners by asking about physical and sexual abuse perpetrated by ‘someone.’ Considering the evidence that half of assault victims are injured by their partners, and the other half are injured by people other than their partners such as family members, neighbors and acquaintances, the focus of the AAS on ‘someone’ as perpetrator is important and critical to differentiate partner violence from other types of violence (Grisso et al., 1999). Third, the AAS does not require participants to report violent behavior only within the context of disagreements as do some other measures.

Sexual Abuse. Participants were asked 1) whether “they had sex because they were scared not to”, and 2) whether “they were physically forced or threats were used to make them have sex or engage in a sex act when they did not want to,” before, during, and/or after pregnancy. A “yes” response to either of these questions for a given period was coded as positive for the presence of sexual abuse.

Childhood abuse. Because prior research suggests that history of childhood abuse may be a risk factor for partner abuse later in life (Gilbert et al., 1997), participants were also asked whether they had any experience of childhood physical and/or sexual abuse by an adult or person at least five years older (coded yes/no).

Data Analytic Strategy

Analyses were performed using SPSS 19.0 and SAS 9.2. Group differences between psychologically abused and non-abused women during pregnancy were explored using Chi-square tests followed by a series of logistic regression analyses with relevant covariates. Experience of IPV was coded for pre-pregnancy, pregnancy, and the postpartum period. No violence, physical violence only, sexual violence only, and both physical and sexual violence categories were created for each time period. Change in type of IPV across the three time periods was examined by latent transition analysis (LTA). LTA is a longitudinal extension of latent class analysis which allows a framework to measure change in categorical latent variables (e.g., class membership) over time (Lanza & Collins, 2008). It is a person-centered multivariate approach which allows researchers (1) to detect unobserved heterogeneity in a given population, (2) to identify meaningful subgroups based on similarity of responses to measured variables, and (3) to examine change in these subgroups across time (Nylund, Asparouhov, & Muthén, 2007). LTA parameter estimates include delta (δ), which represent latent status membership probabilities across the three time periods ; tau (τ), the probability of transitions between latent status membership over time; and rho (ρ), item-response probabilities conditional on latent status membership and time. Interpretation of latent status is made using ρ as this parameter provides an estimate for the amount of correspondence between observed items and the latent statuses (Lanza & Collins, 2008).

In the present study, first a model of IPV classes was established. Second, its measurement invariance was tested across groups of various individual and contextual backgrounds. When measurement invariance was not achieved for a given group comparison, based on examination of parameter estimates, a modified model was specified for the groups compared, and tested for measurement invariance. When measurement invariance was established, group differences were examined in the prevalence and transition of IPV classes across pre-pregnancy, pregnancy, and postpartum using multi-group LTA.

Results

Table 2.2 shows unadjusted group differences in the experience of psychological IPV during pregnancy. Unintended pregnancy, higher gravidity and parity, being younger, non-White, single, unemployed, poor, less educated, and having a partner who did not want the pregnancy, or who had no biological relationship to the delivered baby were significantly associated with experiencing psychological IPV during pregnancy. Follow-up analyses were conducted to examine whether the experience of psychological IPV can be reliably predicted from knowledge of these individual variables. Logistic regression with a forced entry method was performed on psychological IPV (positive, negative*) as the outcome and age at delivery (in years), marital status (single, married*), employment during pregnancy (employed*, unemployed), race (White*, non-White), education (≤ high school, > high school*), income (poor-to-low, moderate-to-high*), parity (numerical value), gravidity (numerical value), pregnancy intendedness of participants (intended*, unintended), pregnancy unwantedness of their partners (unwanted, wanted*), and history of any childhood abuse (yes, no*) as predictors.

Reference groups are indicated by the asterisk. Multicollinearity among predictor variables was assessed by Tolerance and VIF values. Tolerance values were greater than .1, and VIF values were less than 10 for all predictor variables, suggesting that multicollinearity was not present in these data. Regression results indicated that a model of five predictors including education, income, gravidity, pregnancy unwantedness of partner, and history of childhood abuse were statistically reliable in distinguishing between psychological IPV positive and psychological IPV negative women ($\chi^2(11) = 112.502$, $p < .001$). The model correctly classified 95.2 % of cases. Wald test statistics indicated that education, race, income, gravidity, history of childhood abuse, and pregnancy unwantedness of partner were significant predictors of IPV during pregnancy. Women who had high school or less education (OR = 1.70, 95% CI = 1.07-2.7, $p = .025$), poor-to-low income (OR = 1.95, 95% CI = 1.21-3.12, $p = .006$), more than three pregnancies (OR = 1.22, 95% CI = 1.01-1.46, $p = .036$), history of childhood abuse (OR = 1.95, 95% CI = 1.29-2.94, $p = .002$), or a partner who did not want the pregnancy (OR = 3.62, 95% CI = 2.18-6.10, $p < .001$), were at greater risk for IPV during pregnancy relative to their comparison groups.

Table 2.3 shows occurrence of any type of IPV prior to, during, and after pregnancy for the overall sample, whereas Table 2.4 presents occurrence of specific types of IPV across the three time periods. Accordingly, 5.4% of women in the sample reported experiencing IPV at any time in their life. Experiences of IPV both prior to and during pregnancy (1.2 %), and both during and after pregnancy (1.2 %) were common among women. IPV was most prevalent during the postpartum period (1%), followed by pre-pregnancy (0.9%), and pregnancy (0.7). Physical IPV was more prevalent during the postpartum period than during the other time periods, whereas sexual IPV was most common prior to pregnancy.

Question 1: Can a model of IPV classes be identified among women?

Four categorical variables were used as indicators of IPV type and occurrence across pre-pregnancy, pregnancy, and the postpartum period: No IPV, physical IPV only, sexual IPV only, and both physical and sexual IPV. First, several LTA models with 2, 3, 4, and 5 latent classes were tested to identify the best fitting, most parsimonious model. Fit of these models was compared using several statistics and criteria: the denoted G^2 (goodness-of-fit statistic; Goodman, 1970), AIC (Akaike's information criterion; Akaike, 1974), and BIC (Bayesian information criterion; Schwarz, 1978). The G^2 statistic indicates correspondence between the observed and predicted response patterns, with values lower than the degrees of freedom indicating good model fit. AIC and BIC are both penalized-likelihood criteria, i.e., they assess model fit penalized for the number of parameters estimated. Therefore, lower values for these indices suggest good model fit. Table 2.5 shows fit indices for the 2-class, 3-class, 4-class, and 5-class models. Based on examination of these fit indices, the 3-class model was chosen and used in subsequent analyses due to its parsimony and lower G^2, AIC and BIC values.

Question 2: Is there any change in occurrence of types of IPV across the pre-pregnancy, pregnancy, and postpartum time periods?

For each latent status identified, the item-response probabilities (i.e., no IPV, physical IPV only, sexual IPV only, both IPV physical and sexual IPV), the overall probability of membership, and the transition probabilities in latent statuses across time periods are shown in Table 2.6. Examination of item-response probabilities suggested that three latent statuses can be labeled as *No IPV, Predominantly Sexual IPV, and Physical IPV Only*. Accordingly, the No IPV class was defined by absence of any physical or sexual violence. The Predominantly Sexual IPV class was characterized by a greater probability of experiencing sexual violence (0.58) and a lower probability of experiencing both physical and sexual IPV (0.38). Finally, all individuals in the Physical IPV Only class reported experiences of physical violence only.

The most common latent status at each of the three time periods was the No IPV class (97%), followed by Physical IPV Only (approximately 2%) and the Predominantly Sexual IPV (approximately 1%) classes. The membership probability matrix in the same latent status at two consecutive time periods is shown in Table 2.6 diagonally in boldface font. Accordingly, the probability of being in the same latent status in pregnancy as pre-pregnancy was 98.6% for the No IPV, 73% for the Predominantly Sexual IPV, and 27.3% for the Physical IPV Only class. While the probability of remaining in the same category in the postpartum period as during pregnancy was also high for the No IPV class (98.4%), the same probability was lower both for the Predominantly Sexual IPV (0.54) and Physical IPV Only classes (0.39).

Figure 2.1 shows the stability of latent statuses, and Figure 2.2 presents the change in the latent statuses across time. The probability of changing to a different status across the pre-pregnancy, pregnancy, and postpartum time periods is shown by entries off the diagonal of each matrix in Table 2.6. Members of the No IPV class during the pre-pregnancy period were more likely to have Physical IPV Only rather than the Predominantly Sexual IPV status during pregnancy but the probability of this change was very low (0.01). On the other hand, individuals in the Predominantly Sexual IPV class prior to pregnancy tended to move to the No IPV class during pregnancy. Finally, members of the Physical IPV only class before pregnancy were more likely to be in the No IPV class (0.68) during pregnancy. Approximately 5 % of the members in the Physical IPV Only class were likely to move to the Predominantly Sexual IPV class when they become pregnant.

During the transition from pregnancy to the postpartum period, almost all members of the No IPV class (98.4%) maintained their status, whereas more than half of the Physical IPV Only class (60.9%) and 38.1% of the Predominantly Sexual IPV class tended to change into the No IPV status. Approximately 8% of individuals in the Predominantly Sexual IPV class moved to the Physical IPV Only category at the postpartum period. These results suggest that members of the no violence class tended to remain in the same status across the pre-pregnancy, pregnancy, and postpartum periods. Members of the Predominantly Sexual IPV class were more likely to move into the No Violence class during pregnancy, but were at risk of physical IPV (7.7%) during the postpartum period. On the other hand, the Physical IPV Only class tended to change into the No IPV class during the postpartum period, but had a relatively low risk (4.7%) of moving into the Predominantly Sexual IPV during the transition from pre-pregnancy to pregnancy period.

Question 3: How does the probability of latent status membership differ by pregnancy unwantedness of partners (unwanted, wanted), pregnancy intendedness of women (intended, unintended), presence of psychological IPV during pregnancy (yes, no), history of any childhood abuse (yes, no), and marital status (single, married)?

At this final step, the individual and contextual variables listed above were used as grouping variables. First, measurement invariance of the model was tested across each grouping variable. The fit of two models, one with item-response probabilities estimated freely in each group, and one with equality constraints on item-response probabilities, were compared using G^2 difference scores. When measurement invariance was achieved, group differences in latent status memberships and transition probabilities were explored using multigroup analysis. When measurement invariance was not achieved, the differences in the emergence of latent classes were examined and group differences were evaluated accordingly.

Table 2.7 and Table 2.8 show the prevalence of each latent status over time by groups. Latent model measurement invariance was supported for groups differing in pregnancy unwantedness of partners and history of any childhood abuse, but was not achieved for groups differing in pregnancy intendedness (G^2 (12) =7 6.61, p <.001), experience of psychological IPV during pregnancy (G^2 (12) = 52.52, p <.0001), and marital status (G^2 (12) = 136.11, p <.001). Group differences in transition probabilities for latent statuses are presented in Tables 2.9 and 2.10.

Pregnancy unwantedness of partners. The 3-class model was invariant across women with partners who did and did not want their pregnancy. The proportion of women whose partners did not want their pregnancy was higher in the Physical IPV Only class than it was in the Predominantly Sexual IPV class prior to (8% vs. 1%), during (8% vs. 3%), and after pregnancy (9% vs. 1%) . As shown in Table 2.9, women with partners who did not want their pregnancy were more likely to move from No IPV status to Physical IPV Only during pregnancy (4.4% vs. 1%), and from Predominantly Sexual IPV status to Physical IPV Only status during the postpartum period (86.2% vs. 42.2%) than those with partners who wanted their pregnancy. On the other hand, women in the Physical IPV Only class whose partner wanted their pregnancy were more likely to convert to No IPV status during the postpartum period (48.9% vs. 41.6) than those whose partner did not want their pregnancy.

Pregnancy intendedness of women. Lack of evidence for measurement invariance across women with intended and unintended pregnancy suggests that a different latent class model might be valid for these subgroups of women. Examination of parameter estimates suggested that one of the latent classes was redundant. A modified model specification was explored with 2, 3, and 4 classes using pregnancy intendedness as a grouping variable, and the 2-class model yielded better fit. Measurement invariance was examined by testing the model with and without equality constraints on item response probabilities and time across each subgroup. The 2-class latent model was invariant across women with intended and unintended pregnancy (G^2 (8) = 8.94, p = .347). The two classes that emerged were named *No IPV* and *Predominantly Physical IPV*. Women with an unintended pregnancy were slightly less likely to belong to the no IPV status at all time periods compared to those with an intended pregnancy (0.954 vs. 0.986 for pre-pregnancy, 0.954 vs. 0.988 for pregnancy, and 0.956 vs. 0.985 for postpartum). Moreover, those with an unintended pregnancy were slightly more likely to be in the predominantly physical IPV class than those with an intended pregnancy across all time periods (0.04 vs. 0.01). The proportions of individuals in each category across time remained stable.

Among women with an unintended pregnancy, the probability of staying in the No IPV status from pre-pregnancy to pregnancy was slightly lower than women with an intended pregnancy (0.97 vs. 0.99). However, women who had an unintended pregnancy had a slightly higher probability of staying in the Predominantly Physical IPV class than those who had an intended pregnancy (0.41 vs. 0.43) during pregnancy. Women with an unintended pregnancy in the No IPV class were slightly more likely to move to Predominantly Physical IPV status than those with an intended pregnancy (0.006 vs. 0.027) from pre-pregnancy to pregnancy. Having an intended pregnancy was associated with a slightly higher probability of moving from Predominantly Physical IPV to No IPV status during pregnancy than having an unintended pregnancy (0.591 vs. 0.568), whereas unintended pregnancy was associated with a higher probability of transitioning to the No IPV class during the postpartum period than intended pregnancy (44.4 % vs. 56.9 %).

Psychological IPV during pregnancy. The 3-class model was not invariant across women differing in experience of psychological IPV during pregnancy. Models with 2, 3, 4, and 5 classes were tested using psychological IPV as a grouping variable. However, none of the models was invariant across women with and without experiences of psychological IPV during pregnancy. This suggests that the experiences of women psychologically abused during pregnancy may not be captured with the conceptualization of IPV in this study. Therefore, this grouping variable was dropped from subsequent analyses.

History of any childhood abuse. The 3-class model was invariant across women with and without a history of any childhood abuse (G^2 (12) = 1.25, p = .99). Majority of women with and without a history of childhood abuse tended to be in the No IPV class. Compared to women abused during childhood, non-abused women were more likely to be in the Physical IPV Only class at all time periods with higher probability of remaining in the same status from pre-pregnancy to pregnancy (48.6% vs. 36.5%). On the other hand, 47.9% of women abused during childhood in the Physical IPV Only class moved into the Predominantly Sexual IPV class during pregnancy as opposed to 13.7% of those who had no childhood abuse. Women with a history of childhood abuse in the Physical IPV Only status were more likely to be in the No IPV status (58% vs. 49%) during the postpartum period than those with no history of childhood abuse. However, women in the Predominantly Sexual IPV class who abused during childhood were more likely to have Physical IPV Only status during the postpartum period than those who had no history of childhood abuse (55.2% vs. 44.9%).

Marital status. The 3-class model was not invariant across single and married women. Based on examination of item-response probabilities, a 2-class model was specified for these subgroups which showed measurement invariance. The two classes were named *No IPV* and *Predominantly Physical IPV.* The proportion of married women in the No IPV class was greater than that of single women at all periods (approximately 99% vs. 88%) whereas single women were more prevalent in the Predominantly Physical IPV class at each time period (approximately 12% vs. 1%). Single women in the No IPV class were slightly less likely to stay in the same status when they became pregnant than married women (90.7% vs. 99.5%), and if they were in the Predominantly Physical IPV status prior to pregnancy, they were less likely to transition to the No IPV class than married women (51.8% vs. 66.7%). Being single was associated with a greater risk of moving from No IPV status to the Predominantly Physical IPV status during the postpartum period than being married (5.4% vs. less than 1%). On the other hand, the probability of moving from Predominantly Physical IPV to No IPV status was also greater for single women than married women (59.5% vs. 50%) during the postpartum period.

Discussion

The present study examined the stability and change in occurrence of various types of IPV across pre-pregnancy, pregnancy, and postpartum periods, and identified three distinct groups of women: those who experienced no IPV, predominantly sexual IPV, or physical IPV only. Presence of violence in one period increased the likelihood of violence in subsequent periods for all women. Physical violence prior to conception was more likely to continue during pregnancy among women with an unintended pregnancy than among those with an intended pregnancy. Women whose partners did not want their pregnancy were at a greater risk for initiation of physical violence during pregnancy than those with partners who wanted their pregnancy.

Heterogeneity, Stability and Change in Occurrence of Types of IPV Across Time

The present study employed both variable and person-centered methodologies including regression and latent transition analyses, respectively and examined IPV surrounding pregnancy in a population based sample of diverse women. Corroborating the findings of previous research, women with less education, lower income, higher gravidity, a history of childhood abuse, or whose partners did not want the pregnancy were at increased risk for psychological IPV during pregnancy. The operationalization of the psychological IPV variable was based on participants' scores on the WEB scale. Given the continuous process approach to IPV represented by this measure, it is plausible that the subgroups of women who experienced psychological IPV during pregnancy had the same experience before and after pregnancy. Therefore, they may be more vulnerable to chronic stress and associated negative health outcomes. No latent model was successfully specified for this group of women, therefore, further research is needed to identify stability and change in this subgroup in conjunction with relevant covariates such as differences between women and partners in education, income, age and ethnicity in order to develop effective screening and prevention programs.

Participants in this study reported more abusive experiences prior to and after pregnancy than during pregnancy. Physical abuse was most prevalent during the postpartum period, whereas sexual abuse was most prevalent prior to pregnancy. These findings initially suggested the possibility that pregnancy may be a protective factor against IPV for some women which was further explored in the LTA analyses. LTA analysis identified 3 distinct groups of women defined by experiences of No IPV, Predominantly Sexual IPV, and Physical IPV Only. As expected, a majority of women in the study experienced no IPV across the pre-pregnancy, pregnancy, and postpartum periods. Women were more likely to experience physical IPV rather than predominantly sexual IPV across the three time periods. The most vulnerable women were in the Predominantly Sexual IPV class as experiences of these women were defined by sexual abuse which sometimes co-occurred with physical abuse. The highest stability was observed in the No IPV class across the three time periods. The Predominantly Sexual IPV class was more stable during pregnancy than the postpartum period, whereas the Physical IPV Only class was more likely to remain the same during the postpartum period compared to pre-pregnancy. Individuals in the Predominantly Sexual IPV and the Physical IPV Only classes who changed were more likely to move to no-violence status across the pre-pregnancy, pregnancy, and postpartum periods. However, those in the physical IPV only status prior to pregnancy were at risk for experiencing Predominantly Sexual IPV during pregnancy. Moreover, women in the Predominantly Sexual IPV individuals during pregnancy were more likely to be in the Physical IPV only class during the postpartum period.

These findings suggest that women who do not experience violence prior to pregnancy tend not to experience it during pregnancy or the postpartum period either. For a woman with no prior violence experience, the probability of violence initiation during pregnancy was 1%, suggesting that frequency of abuse for these women does not increase during pregnancy relative to pre-pregnancy. The study findings also showed that for all women, violence experienced in one period tends to be present in the subsequent period, suggesting the continuity of violence regardless of the pregnancy experience (Amaro et al., 1990; Helton et al., 1987; Stewart & Cecutti, 1993). Moreover, pregnancy may be a protective factor for some women as evident by the change observed in the status of some women from experiencing predominantly sexual IPV and physical IPV only prior to pregnancy to no IPV during pregnancy. These findings corroborate prior research which has reported a decrease in abuse during pregnancy (e.g., Martin et al., 2001; Saltzman et al., 2003), although other studies have not found such a decrease (e.g., Amaro et al., 1990).

One notable finding of the present study is that a small subgroup of women who have persistent violence at all three time periods tend to experience a change in the type of violence during the transitions from pre-pregnancy to the postpartum period. Approximately 5% of women experiencing physical IPV only prior to pregnancy had predominantly sexual IPV during pregnancy. Moreover, 8% of women who had predominantly sexual IPV during pregnancy experienced physical IPV only during the postpartum period. The continuity of IPV and the change in the occurrences of types of IPV for some women during the transition from pregnancy to the postpartum period suggest that postpartum might be particularly stressful due to the challenges of taking care of a newborn (Graham et al., 2002), especially for those with limited resources, and therefore, may be a particularly high-risk time period for continuation of IPV in different patterns or types (Charles & Perreira, 2007; Shoffner, 2008). The study findings suggest that the types of IPV change for some women across the pre-pregnancy, pregnancy, and postpartum periods. The observed changes in the occurrences of the types of IPV might be due to changes in psychological and emotional states of both women and their partners in presence of a baby. Future research is needed to examine the predictors of these transitions between types of IPV across time.

Examining group differences in the stability and change of IPV types across time provided some contextual information about the observed patterns. Among women who did not experience any violence prior to pregnancy, the probability of initiation of physical violence was relatively high during pregnancy for those whose partner did not want the pregnancy. Women who experienced predominantly sexual violence prior to pregnancy were also at risk for physical abuse during pregnancy if their partner did not want the pregnancy. Among women who were physically abused prior to pregnancy, those whose partner wanted the pregnancy were less likely to experience any violence during pregnancy than those whose partner didn't want the pregnancy. Similarly, women with unintended pregnancy were more likely to experience violence during pregnancy. Women with unintended pregnancy who experience predominantly sexual abuse prior to pregnancy were more likely to have the same experience during pregnancy, and no violence experiences during the postpartum period than those with intended pregnancy. Unintended pregnancy may itself be the result of sexual abuse or women's reduced ability to control their reproductive health in the presence of an extremely controlling partner (Heise, 1993; Miller et al., 2010; Williams, Larsen, & McCloskey, 2008). Temporal associations between unintended pregnancy and violence warrant further investigation to address such possibilities.

As reported by several other studies (e.g., Cokkinides & Coker, 1998; Gazmararian et al., 1996), single women were more likely to experience predominantly physical abuse than married women at each time period. Compared to married women, single women who did not experience violence during pregnancy were also at a greater risk of experiencing physical violence during the postpartum period. It is important to note that the 3-class model was not invariant across these subgroups of women differing in pregnancy intendedness and marital status. indicating that the 3-class model was not appropriate to describe stability and change in the types of IPV experiences for these women. Subsequent analyses showed that 2-class model was more accurate to describe experiences of these women. Therefore, all the reported results were based on the 2-class model specified for these groups.

Finally, unlike studies reporting childhood abuse as a risk factor for IPV (e.g., Swartout, Cook, & White, 2012), history of any childhood abuse did not increase the likelihood of abuse at any time for women in this study. Indeed, among women abused prior to pregnancy, continuity of violence during pregnancy was more likely if women had a history of childhood abuse. Moreover, among women who experienced predominantly sexual violence prior to pregnancy, no history of childhood abuse was associated with a greater risk for experiencing physical violence during pregnancy than history of childhood abuse. Without knowing about other factors that might be associated with a history of childhood abuse and IPV later in life, it is hard to identify the underlying causes of these observed group differences; however, one could conjecture that women who suffered abuse in childhood may have acquired some effective coping mechanisms or strategies to deal with an abusive partner based on their previous history.

Study Strengths and Limitations

The current study makes a unique contribution to the IPV literature by examining the stability and change in occurrence of different types of IPV across pre-pregnancy, pregnancy, and postpartum periods in the presence of some contextual factors. The study has several strengths. First, the study used both variable centered and person-centered approaches to analyze the obtained data. Using a variable centered approach and associated methodologies including bivariate and multivariate tests, group differences in the prevalence of psychological IPV during pregnancy were examined in the presence of potential predictors and risk factors. Using a person-centered approach and an associated methodology including LTA, the stability and change prior to, during, and after pregnancy was modeled and group differences in the obtained latent statuses were explored. While the results of the variable-centered analyses may help us understand the population of abused women in general, the results by the person-centered analyses may allow us to identify heterogeneity of IPV experiences and design tailored intervention and prevention programs for abused women. Second, the study had a large, representative sample with a high participation rate which increased statistical power to detect small effects. Third, instead of collecting data about a single time period which has been common in prior research, the current study asked respondents to report on IPV occurring in three time periods: prior to, during, and after pregnancy and to enhance reliability, these reports were limited to 6 months prior to and after pregnancy. Finally, partner abuse was assessed using validated measurement tools such as the AAS and the WEB that have high reliability, sensitivity, and specificity.

The present study also had some limitations. First, only physical and sexual IPV were modeled in LTA. Both the National Institute of Justice and the National Center on Injury and Prevention and Control recommend that the definition of violence should incorporate physical, sexual, emotional, and economic abuse (Centers for Disease Control and Prevention, 2000; Osattin & Short, 1998). The present study included data on psychological violence but for the pregnancy period only, and therefore these data could not be examined for stability and change over time. Instead variable-centered methodologies including logistic regression were used to examine predictors of psychological violence during pregnancy. Second, study findings may be vulnerable to recall bias as the IPV assessment for each time period was retrospective. A majority of existing research relies on a single time point retrospective assessment of 12 months prior to pregnancy, increasing the likelihood of recall bias (Jasinski, 2004; Silverman et al., 2006a; Silverman et al., 2006b). The present study assessed IPV 6 months prior to pregnancy, during pregnancy, and within 3 to 6 months following delivery. All interviews were conducted within 3 to 6 months following delivery to minimize the likelihood of recall bias. Nonetheless, recall bias may still be a threat to the validity of conclusions from this study. For example, the prevalence of IPV for pre-pregnancy or pregnancy may have been underestimated because of possibly poorer recall for the earliest time periods, coping methods involving repression of distressing past events, or the enhanced salience of more recent abuse. Type of abuse may also affect the extent to which it is remembered.

A third limitation pertains to the fact that the present study used computer assisted telephone interviews. This method of data collection limits recruitment to people living in households with telephones or those owning mobile phones (Keeter, 1995; Lavrakas, 1993). Fourth, generalizability of study findings is limited to women with low-risk pregnancies delivering a singleton live baby. Furthermore, the study sample was recruited from four counties in Iowa. Although these counties are known for being ethnically and socioeconomically diverse, the sample was predominantly White, highly educated with moderate-to-high income, suggesting that non-White, less educated, poor income groups may have been underrepresented. Finally, study findings are based on probabilities; therefore, no causal relationships can be inferred regarding the stability and change of IPV types across pre-pregnancy, pregnancy, and postpartum periods. Although causality cannot be definitively established in a study of this topic, prospective, longitudinal research can help to bolster confidence in the validity of conclusions about changes in IPV surrounding pregnancy.

In conclusion, intimate partner violence surrounding pregnancy is a complex problem which requires a person-centered approach and corresponding data analytic techniques to understand its etiology and resolution. Pregnancy, which is a particularly vulnerable period for women, but one in which most women have contact with health care providers, is a fitting and opportune context in which to investigate and identify distinct patterns of violence as well as their stability across time and to develop effective screening, prevention, and intervention programs.

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Table 2.1

Participant Characteristics (N = 2709)

Variables	% (N) or Mean ± SD
Age at delivery	28.32 ± 5.45
Parity	0.86 ± 1.01
Gravidity	2.39 ± 1.46
Ethnicity	
White	88.4 % (2394)
Black	5.1 % (139)
Asian or Pacific Islander	3.4 % (93)
Mixed race	3.1 % (83)
Education	
<= High school	19.8 % (536)
Some college, associate degree or vocational school	32.5 % (880)
College graduate (BA)	33.1 % (898)
Graduate or professional school	14.6 % (395)
Marital status	
Married or cohabitating as if married	86.9 % (2355)
Single	10.3 % (279)
Missing	2.8 % (75)
Annual income*	Range: $0 - 800,000 Median: $ 60,000
Poor	17.4 % (471)
Near poor to low income	15.6 % (423)
Moderate income	31.7 % (859)
High income	35.3 % (956)
Employment status during pregnancy	
Employed	79 % (2134)
Unemployed	21 % (575)
Pregnancy intendedness of participants	
Intended	57.7 % (1564)
Unintended	42.3 % (1145)

* An income-poverty ratio (IPR) was calculated by dividing participants' annual household income by the number of people living with them. The following cut-off scores were used to determine income groups: *Poor* if IPR <1.0; *near poor to low income* if IPR = > 1.0 and < 2.0; *moderate income* if IPR= > 2.0 and < 4.0; *high income* if IPR = > 4.

Table 2.2

Differences Between Psychological IPV Negative and Positive Women during Pregnancy

	Psychological IPV negative		Psychological IPV positive			
Groups	N	%	N	%	Chi-square test	*p*-value
Age					χ2(1)=25.418	<.001
Younger	1274	*89.7*	147	*10.3*		
Older	1222	*94.9*	66	*5.1*		
Ethnicity					χ2(1)=20.299	<.001
White	2226	*93*	168	*7*		
Non-White	270	*85.7*	45	*14.3*		
Education					χ2(1)=76.633	<.001
=< High school	445	*83*	91	*17*		
> High school	2051	*94.4*	122	*5.6*		
Marital status					χ2(1)=162.543	<.001
Single	212	*76*	67	*24*		
Married	2254	*95.7*	101	*4.3*		
Income					χ2(1)=125.203	<.001
Poor-to-low	750	*83.9*	144	*16.1*		
Moderate-to-high	1746	*96.2*	69	*3.8*		
Employment					χ2(1)=9.414	<.01
Unemployed	1983	*92.9*	151	*7.1*		
Employed	483	*89*	60	*11*		
Parity					χ2(1)=7.734	<.01
0-1	1963	*92.9*	150	7.1		
2+	533	*89.4*	63	10.6		
Gravidity					χ2(1)=10.964	<.001
0-2	1564	*93.5*	109	6.5		
3+	932	*90*	104	10		

Table 2.2 (cont'd)

Differences Between Psychological IPV Negative and Positive Women during Pregnancy

	Psychological IPV negative		Psychological IPV positive			
Groups	N	%	N	%	Chi-square test	*p*-value
Pregnancy intendedness of women					χ2(1)=61.892	<.001
Intended	1494	*95.6*	68	4.4		
Unintended	1001	*87.4*	144	12.6		
Pregnancy wantedness of partners					χ2(1)=94.638	<.001
Wanted	140	*76.9*	42	23.1		
Unwanted	2212	*95.1*	115	4.9		
Partner: Biological father of the delivered baby					χ2(1)=25.199	<.001
Yes	2353	*93.7*	157	6.3		
No	14	*66.7*	7	33.3		

Table 2.3

Occurrence of Any Type of IPV Across Different Time Periods

	IPV at any time N *(%)*	IPV only prior to pregnancy N *(%)*	IPV only during pregnancy N *(%)*	IPV only during postpartum N *(%)*	IPV both prior to and during pregnancy N *(%)*	IPV both during and after pregnancy N *(%)*	IPV prior to, during, and after pregnancy N *(%)*
Yes	145 *(5.4%)*	25 *(0.9%)*	18 *(0.7%)*	27 *(1%)*	32 *(1.2%)*	32 *(1.2%)*	14 *(.5%)*
No	2564 *(94.6%)*	2684 *(99.1%)*	2691 *(99.3%)*	2682 *(99%)*	2677 *(98.8)*	2677 *(98.8%)*	2695 *(99.5%)*

Table 2.4

Occurrence and Type of IPV Prior to Pregnancy, During Pregnancy, and Postpartum Period

Occurrence and Type of IPV	Prior to Pregnancy	During Pregnancy	During Postpartum
	N (%)	N (%)	N (%)
No physical or sexual IPV	2626 (97.2%)	2635 (97.4%)	2631 (97.3%)
Physical IPV only	51 (1.9%)	46 (1.7%)	56 (2.1%)
Sexual IPV only	17 (0.6%)	13 (0.5%)	11 (0.4%)
Both physical and sexual IPV	8 (0.3 %)	12 (0.4%)	7 (0.3%)

Table 2.5

Comparisons of Latent Class Models for Full Sample

Model	Description	G^2	Degrees of freedom	AIC	BIC
2	Two-class	217.26	500	239.26	304.21
3*	**Three-class**	**114.86**	**488**	**160.86**	**296.66**
4	Four-class	112.76	472	190.76	421.03
5	Five-class	112.74	452	230.74	579.09

* The latent class model accepted is shown in boldface.

Table 2.6

LTA Results for Full Sample

	Latent Status		
*Item-Response Probabilities (Rho estimates)	No IPV	Predominantly Sexual IPV	Physical IPV Only
No IPV			
No	0.00	0.963	1.0
Yes	1.0	0.366	0
Physical IPV Only			
No	1.0	1.0	0
Yes	0	0	1.0
Sexual IPV Only			
No	1.0	0.419	1.0
Yes	0	0.581	0
Both Physical and Sexual IPV			
No	1.0	0.617	1.0
Yes	0	0.382	0
Prevalence of Latent Statuses (Delta estimates)			
Time 1: Pre-pregnancy	0.971	0.001	0.019
Time 2: Pregnancy	0.973	0.010	0.017
Time 3: Postpartum	0.972	0.007	0.021
***Transition probabilities (Tau estimates)*			
Time 1: Pre-pregnancy (rows) -> Time 2: Pregnancy (columns)			
No IPV	**0.986**	0.002	0.012
Predominantly Sexual IPV	0.270	**0.730**	0
Physical IPV Only	0.680	0.047	**0.273**
Time2: Pregnancy (rows) -> Time 3: Postpartum (columns)			
No IPV	**0.984**	0.001	0.014
Predominantly Sexual IPV	0.381	**0.542**	0.078
Physical IPV Only	0.609	0	**0.391**

* Entries in bold font indicate membership in the same latent status at two consecutive times.

Table 2.7

Prevalence of Latent Statuses by Groups for the 3-Class Model

	Latent Status		
Grouping Variables	No IPV	Predominantly Sexual IPV	Physical IPV Only
Pregnancy unwantedness of partner			
Unwanted by partner			
Time 1: Pre-pregnancy	0.910	0.011	0.080
Time 2: Pregnancy	0.894	0.029	0.077
Time 3: Postpartum	0.896	0.011	0.093
Wanted by partner			
Time 1: Pre-pregnancy	0.966	0.018	0.016
Time 2: Pregnancy	0.968	0.021	0.011
Time 3: Postpartum	0.964	0.018	0.018
History of any childhood abuse			
Yes			
Time 1: Pre-pregnancy	0.967	0.015	0.018
Time 2: Pregnancy	0.967	0.015	0.017
Time 3: Postpartum	0.969	0.015	0.016
No			
Time 1: Pre-pregnancy	0.929	0.014	0.057
Time 2: Pregnancy	0.934	0.017	0.049
Time 3: Postpartum	0.928	0.013	0.059

* Only the groups for which measurement invariance of the 3-class model was achieved are shown here.

Table 2.8

*Prevalence of Latent Statuses by Groups for the 2-Class Model**

	Latent Status	
Grouping Variables	No IPV	Predominantly Physical IPV
Pregnancy intendedness of woman		
Intended by woman		
Time 1: Pre-pregnancy	0.986	0.014
Time 2: Pregnancy	0.988	0.011
Time 3: Postpartum	0.985	0.014
Unintended by woman		
Time 1: Pre-pregnancy	0.954	0.046
Time 2: Pregnancy	0.954	0.045
Time 3: Postpartum	0.956	0.044
Marital status		
Single		
Time 1: Pre-pregnancy	0.888	0.112
Time 2: Pregnancy	0.863	0.136
Time 3: Postpartum	0.898	0.102
Married		
Time 1: Pre-pregnancy	0.989	0.011
Time 2: Pregnancy	0.992	0.008
Time 3: Postpartum	0.988	0.012

* Only the groups for which measurement invariance of the 2-class model was achieved are shown here.

Table 2.9

Group Differences in Transition Probabilities for the 3-Class Invariant Models

	Latent Status		
Groups and Transition Probabilities	No IPV	Predominantly Sexual IPV	Physical IPV Only
Pregnancy unwantedness of partner			
Unwanted			
Time 1: Pre-pregnancy (rows) -> Time 2: Pregnancy (columns)			
No IPV	**0.951**	0.005	0.044
Predominantly Sexual IPV	0.898	**0.008**	0.094
Physical IPV	0.239	0.313	**0.447**
Time2: Pregnancy (rows) -> Time 3: Postpartum (columns)			
No IPV	**0.962**	0.011	0.027
Predominantly Sexual IPV	0.135	**0.003**	0.862
Physical IPV	0.416	0.012	**0.571**
Wanted			
Time 1: Pre-pregnancy (rows) -> Time 2: Pregnancy (columns)			
No IPV	**0.981**	0.013	0.006
Predominantly Sexual IPV	0.975	**0.018**	0.007
Physical IPV	0.164	0.511	**0.324**
Time2: Pregnancy (rows) -> Time 3: Postpartum (columns)			
No IPV	**0.978**	0.018	0.004
Predominantly Sexual IPV	0.564	**0.015**	0.422
Physical IPV	0.489	0.011	**0.500**

Table 2.9 (cont'd)

Group Differences in Transition Probabilities for the 3-Class Invariant Model

	Latent Status		
Groups and Transition Probabilities	No IPV	Predominantly Sexual IPV	Physical IPV Only
History of Any Childhood Abuse			
Yes			
Time 1: Pre-pregnancy (rows) -> Time 2: Pregnancy (columns)			
No IPV	**0.985**	0.007	0.009
Predominantly Sexual IPV	0.972	**0.013**	0.015
Physical IPV	0.035	0.479	**0.486**
Time2: Pregnancy (rows) -> Time 3: Postpartum (columns)			
No IPV	**0.984**	0.015	0.001
Predominantly Sexual IPV	0.437	**0.011**	0.552
Physical IPV	0.576	0.013	**0.412**
No			
Time 1: Pre-pregnancy (rows) -> Time 2: Pregnancy (columns)			
No IPV	**0.960**	0.010	0.029
Predominantly Sexual IPV	0.937	**0.015**	0.049
Physical IPV	0.497	0.137	**0.365**
Time2: Pregnancy (rows) -> Time 3: Postpartum (columns)			
No IPV	**0.959**	0.013	0.029
Predominantly Sexual IPV	0.540	**0.011**	0.449
Physical IPV	0.488	0.012	**0.500**

Table 2.10

Group Differences in Transition Probabilities for the 2-Class Invariant Model

	Latent Status	
Groups and Transition Probabilities	No IPV	Predominantly Physical IPV
Marital status		
Single		
Time 1: Pre-pregnancy (rows) -> Time 2: Pregnancy (columns)		
No IPV	**0.907**	0.093
Predominantly Physical IPV	0.518	**0.482**
Time2: Pregnancy (rows) -> Time 3: Postpartum (columns)		
No IPV	**0.946**	0.054
Predominantly Physical IPV	0.595	**0.405**
Married		
Time 1: Pre-pregnancy (rows) -> Time 2: Pregnancy (columns)		
No IPV	**0.995**	0.004
Predominantly Physical IPV	0.667	**0.332**
Time2: Pregnancy (rows) -> Time 3: Postpartum (columns)		
No IPV	**0.992**	0.008
Predominantly Physical IPV	0.500	**0.500**

Table 2.10 (cont'd)

Group Differences in Transition Probabilities for the 2-Class Invariant Model

	Latent Status	
Groups and Transition Probabilities	No IPV	Predominantly Physical IPV
Pregnancy Intendedness		
Intended		
Time 1: Pre-pregnancy (rows) -> Time 2: Pregnancy (columns)		
No IPV	**0.994**	0.006
Predominantly Physical IPV	0.591	**0.409**
Time2: Pregnancy (rows) -> Time 3: Postpartum (columns)		
No IPV	**0.992**	0.008
Predominantly Physical IPV	0.444	**0.555**
Unintended		
Time 1: Pre-pregnancy (rows) -> Time 2: Pregnancy (columns)		
No IPV	**0.973**	0.027
Predominantly Physical IPV	0.568	**0.432**
Time2: Pregnancy (rows) -> Time 3: Postpartum (columns)		
No IPV	**0.974**	0.026
Predominantly Physical IPV	0.569	**0.431**

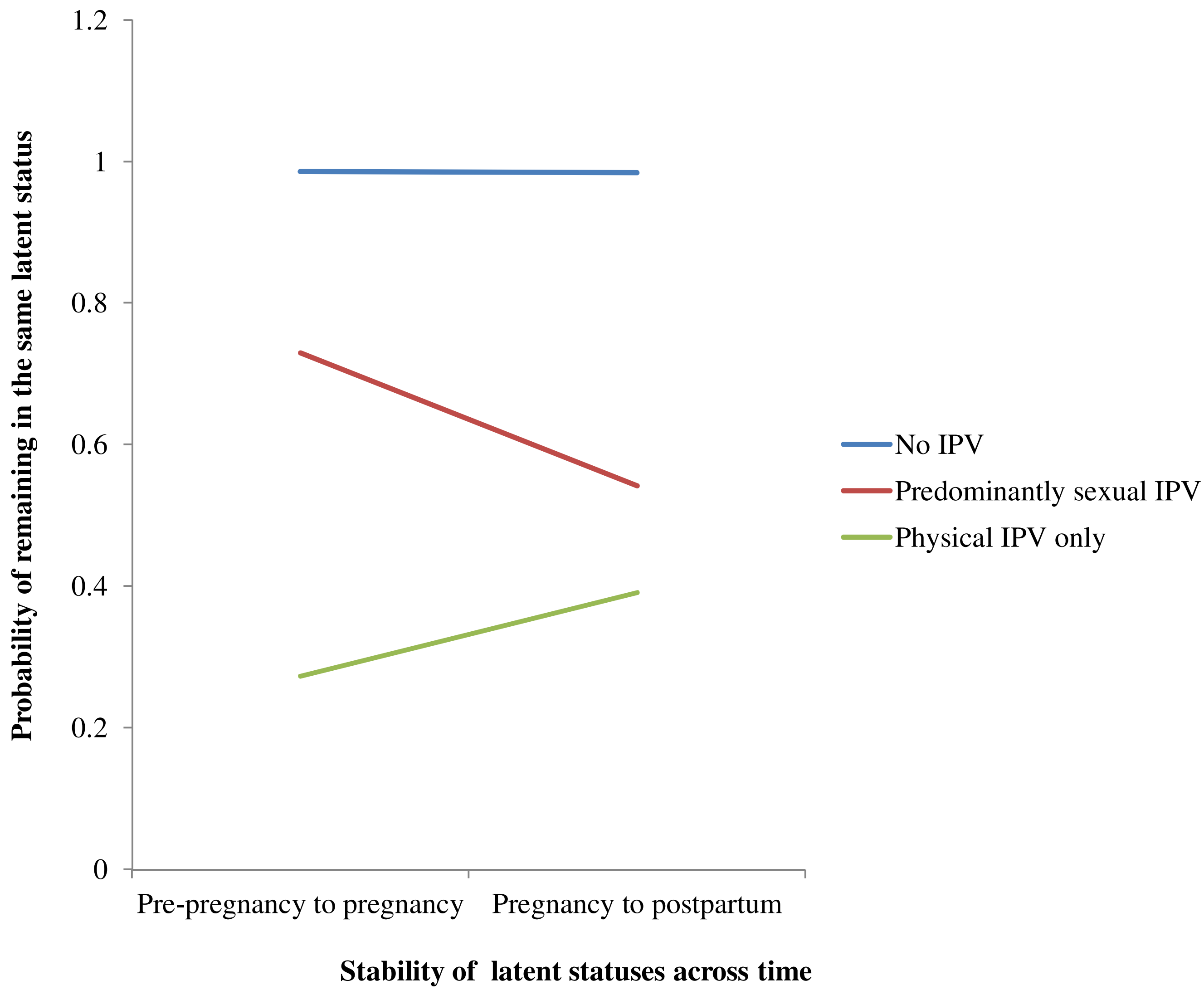

Figure 2.1. Stability of each latent status across time. Individuals in the No IPV class remained stable. Individuals in the Predominantly Sexual IPV class were more likely to change their status during the postpartum period, whereas those in the Physical IPV Only class were more likely to stay in the same status during the postpartum period.

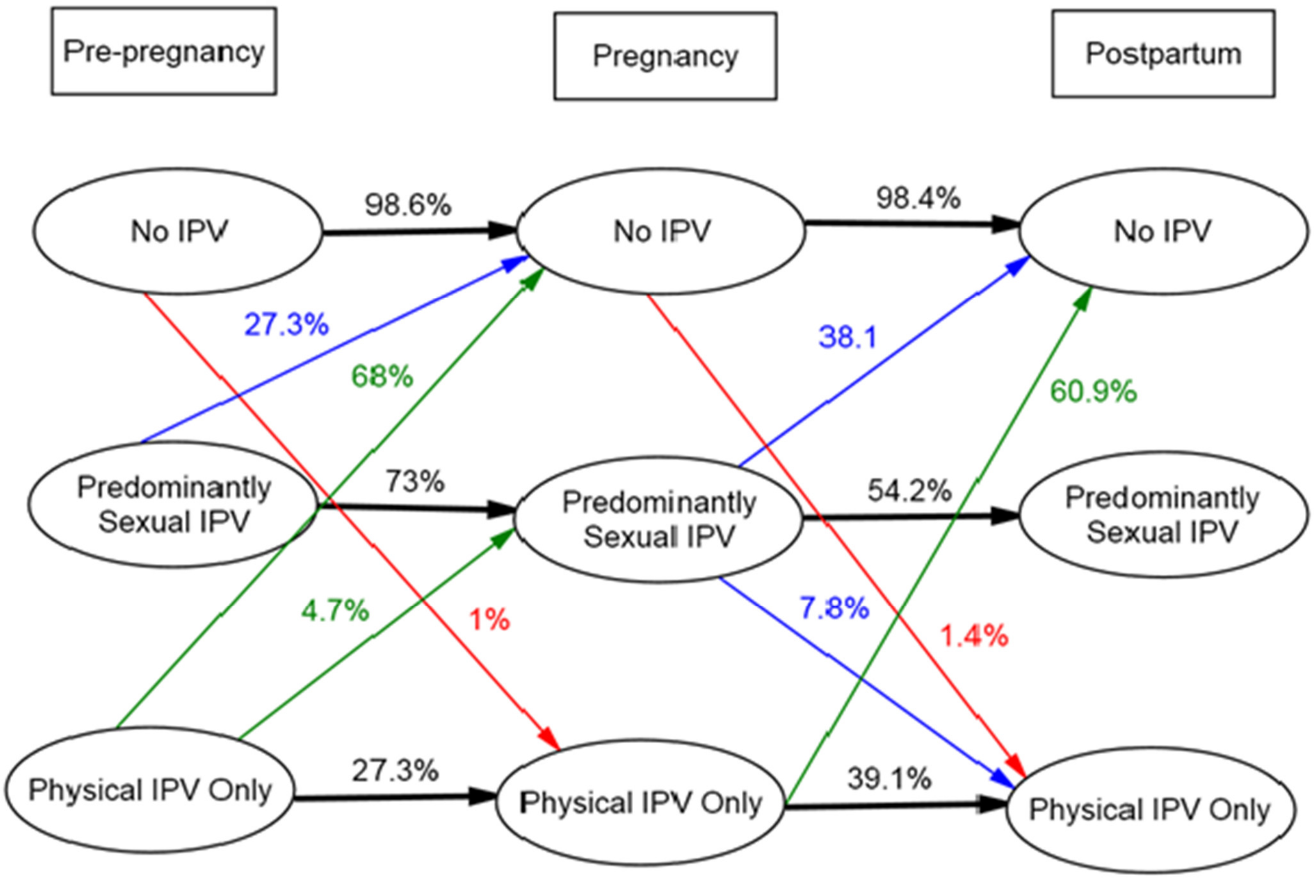

Figure 2.2. Probability of change in each latent status across pre-pregnancy, pregnancy, and postpartum. Black lines represent stability within each latent status, red lines represents No IPV status, blue lines are Predominantly Sexual IPV status, and green lines are Physical IPV Only status.

When So-Called Cozy Home and Mother's Womb Are Not Safe: Do Prenatal Maternal Stress and Intimate Partner Violence Predict Fetal Distress and Unplanned Cesarean Delivery?

The past few decades have seen a significant increase in rates of cesarean births around the world. Documented rates range from 20% to 35% of all births in high income countries with a similar trend in newly industrialized countries (Lumbiganon et al., 2010; Villar et al., 2006). The steady increase in cesarean deliveries has been attributed to defensive medicine, increased perception of safety, financial incentives, excessive weight gain during pregnancy, and an increased number of women of advanced maternal age (Bailit, Love, & Mercer, 2004; Luthy, Malmgren, Zingheim, & Leininger, 2003; Villar et al., 2006). Increased rates of cesarean have raised concerns about maternal and neonatal health outcomes, particularly due to the fact that surgical delivery is associated with greater likelihood of maternal and infant mortality and morbidity than vaginal delivery (Blüml, Stammler-Safar, Reitinger, Resch, Naderer, & Leithner, 2012; Hager et al., 2004) and although understudied, with adverse psychological outcomes, as well (Lobel & DeLuca, 2007). A majority of studies on cesarean delivery have focused on the risk of death and medical complications associated with surgical delivery. Psychosocial and behavioral factors that affect the likelihood of cesarean delivery haven't been studied sufficiently (Lobel & DeLuca, 2007).

Converging evidence both from animal and human studies indicates that stress during pregnancy is a risk factor for adverse birth outcomes such as preterm delivery and low birthweight (e.g., Alderdice & Lynn, 2009; Beydoun & Saftlas, 2008; Glynn, Dunkel-Schetter, Hobel, & Sandman, 2008; Lobel, Cannella, Graham, DeVincent, Schneider, & Meyer, 2008). Moreover, prenatal maternal stress (PNMS) is associated with increased likelihood of analgesia receipt and unplanned cesarean delivery (Saunders, Lobel, Veloso, & Meyer, 2006). Effects of PNMS on adverse birth outcomes including surgical delivery are more likely to be observed when stress is defined using a multivariate approach (Lobel, 1994; Lobel, Hamilton, & Cannella, 2008). PNMS has been shown to predict maternal and neonatal outcomes through health impairing behaviors and changes in neuroendocrine, immune, vascular, and metabolic functioning (Arck, 2010; Coussons-Read et al., 2012; McEwen, 2008; Rondo, 2003).

Intimate partner violence (IPV) during pregnancy is also associated with multiple adverse maternal and neonatal outcomes. Low birth weight, preterm delivery, miscarriages and fetal deaths, insufficient gestational weight gain, failure to breastfeed or early cessation of breastfeeding, and maternal depression are the most commonly reported adverse outcomes of prenatal abuse (Coker et al., 2004). Pregnant women who experience IPV have a 37 % higher risk of obstetric complications such as hypertension, premature rupture of membranes and anemia (Kaye, Mirembe, Bantebya, Johansson, & Ekstrom, 2006). Several studies indicate that prenatal IPV increases risk of fetal death (spontaneous abortion, perinatal loss, or miscarriage; e.g., Ellsberg et al., 2008), with one study indicating a linear association between severity of violence and risk of this outcome (Morland et al., 2008). Ahmed and colleagues found the risk of fetal death to be 2.6 times higher among abused pregnant women than non-abused pregnant women, after controlling for sociodemographic and maternal health behaviors (Ahmed, Koenig, & Stephenson, 2006). Moreover, abused pregnant women are more likely to have renal tract infections, and to undergo operative delivery - regardless of their age, socio-economic status and quality of prenatal care –than non-abused pregnant women (Boy & Salihu, 2004; Cokkinides et al., 1999). As a result of these outcomes, IPV is associated with greater health care utilization, including hospitalization and emergency room visits, and hence higher costs both in pregnant and non-pregnant women (e.g., Chambliss, 2008; Coker, Reeder, Fadden, & Smith, 2004). The estimated annual health care cost of IPV is approximately $4.1 billion (National Center for Injury Prevention and Control, 2003).

Two types of mechanisms are likely responsible for the impact of IPV on maternal and neonatal health outcomes: direct and indirect. Direct mechanisms are medical conditions such as abruption (separation of the placenta from the uterus) that can result from blows to the abdomen; indirect mechanisms are psychosocial and behavioral factors, including high levels of stress, limited access to prenatal care, maladaptive coping behaviors such as smoking, alcohol and drug abuse, and insufficient maternal nutrition experienced by women as a result of exposure to violence around the time of pregnancy (Chrisler & Ferguson, 2006; Coker et al., 2004; Cokkinides et al., 1999; Petersen et al., 1997). Each of these factors is known to contribute to poor birth outcomes (e.g., Dunkel-Schetter & Lobel, 2011; Lobel et al., 2008).

Despite the well-documented negative effects of PNMS and IPV on maternal and neonatal health outcomes, the associations of PNMS and IPV with fetal distress and unplanned cesarean delivery haven't been studied in a single model so far. The present study aims to build and expand on previous research by examining whether PNMS and IPV predict two outcomes: 1) fetal heart tracing (FHT) abnormalities, an indicator of fetal distress during childbirth that increases the likelihood of unplanned cesarean delivery, and 2) unplanned cesarean delivery itself, after controlling for obstetric and maternal risk for surgical birth. In the present study, unplanned cesarean delivery was defined as either a cesarean performed after labor has begun (as a result of unexpected maternal and fetal complications during an attempt at vaginal delivery) or as an emergency cesarean performed prior to labor (Lobel & DeLuca, 2007). It was hypothesized that there would be a positive correlation between PNMS and IPV, and both PNMS and IPV would be associated with increased likelihood of fetal distress and unplanned cesarean delivery regardless of a woman's cesarean risk due to other obstetric and maternal characteristics.

Method

Participants and Procedure

The study sample was derived from a larger project examining pregnancy, partner abuse, and birth variables. Analyses included only respondents who had complete data on all study variables including medical chart abstractions. Women who did not have complete data were more likely to be single, poor, less educated than those who had complete data ($p < .001$). The sample included 1,652 women from Iowa who delivered a singleton live born infant between May 1, 2002 and June 30, 2005. Eligibility criteria included being above the age of 18 at the time of delivery, speaking English, and having no history of Type 1 or Type 2 diabetes mellitus, systemic lupus, or chronic renal disease. A majority of participants were White, married, with more than high school education and with moderate-to-high income. Sample characteristics are presented in Table 3.1.

Eligible participants were located using Iowa birth certificate files and were contacted by telephone. Participants were asked to give consent for their medical chart abstractions and participation. Data on PNMS and IPV were collected retrospectively within 3 to 6 months following delivery through one-hour computer-assisted telephone interviews conducted by trained, experienced female interviewers. After completion of the interviews, participants were offered information on local and statewide intimate partner violence resources that provide counseling and shelter. This information was given over the telephone unless participants asked it to be mailed without any safety concerns. Compensation of $30 was provided to participants upon completion of the interview.

Measures

PNMS. Using an operationalization suggested by prior research (Lobel et al., 2008) pregnancy-specific distress, number of major life events, major life events distress, state anxiety, and perceived stress were used to assess PNMS.

Pregnancy-Specific Distress. The 17-item Revised Prenatal Distress Questionnaire (NuPDQ; Lobel et al., 2008) was used to assess pregnancy-related distress. Prior research has shown that the NuPDQ has high internal consistency and predictive validity in pregnant women (Alderdice, Lynn, & Lobel, 2012). The scale had high consistency in the present study as well (α = 0.79). Participants were asked to indicate if they felt bothered, upset or worried about different aspects of pregnancy (e.g., physical symptoms, bodily changes, labor and delivery) on a 4-point scale ranging from "not at all" (1) to "very much" (4). A total NuPDQ score for each participant was calculated by summing item responses.

Major Life Events. The Prenatal Life Events Scale (PLES) adapted from previous research with pregnant women (Lobel, Dunkel-Schetter, & Scrimshaw, 1992; Lobel et al., 2000) was used to assess stressful life events experienced by participants. Prior research shows that the PLES correlates well with other indicators of stress such as the Perceived Stress Scale and the Prenatal Distress Questionnaire (Lobel, DeVincent, Kaminer, & Meyer, 2000; Lobel et al., 2008). Participants were asked to indicate the occurrence of 28 life events during their 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 also reported how undesirable or negative the event was on a 4-point scale ranging from "not at all" (0) to "very much" (3). For each participant, number of major life events was recorded, and a mean life event distress score was calculated by summing distress ratings and dividing them by the total number of life events reported.

State Anxiety. The 10-item State Anxiety subscale of the State Trait Personality Inventory (STPI; Spielberger, 1995) was used to measure how anxious participants felt during their pregnancy. Prior research substantiates that the STPI has high internal consistency (α = .95) and convergent and predictive validity in samples of pregnant women (Hamilton & Lobel, 2008; Lobel et al., 2000, 2008). Participants rated the applicability of items such as “I felt nervous,” and “I was worried,” during their pregnancy on a 4-point scale ranging from “not at all” (0) to “very much” (3). A total state anxiety score for each participant was calculated by summing item responses. The scale was internally consistent, Cronbach's $\alpha = 0.80$.

Perceived Stress. The 4-item version of the Perceived Stress Scale (PSS; Cohen & Williamson, 1988) was used to measure appraisals of stress during pregnancy. Previous research used the PSS in samples of pregnant women, and reported high internal consistency for the scale (Lobel et al., 2000; Lobel & Dunkel-Schetter, 1990). Participants were asked to report how frequently they felt unable to overcome difficulties in their lives during their pregnancy on a 5-point scale ranging from “never” (1) to “very often” (5). A total perceived stress score was calculated for each participant. The scale was internally consistent ($\alpha = 0.75$).

Psychological IPV. Partner abuse during pregnancy was assessed with the 10-item Women’s Experiences with Battering scale (WEB; Smith, Earp, & DeVellis, 1995). The WEB operationalizes IPV as a *continuous process* rather than *a discrete event,* and focuses on the enduring nature of violence and victimization. Therefore, instead of focusing on the behaviors of abusive partners, it assesses women’s perceptions of their vulnerability to physical danger and their sense of loss of power and control in their intimate relationships. Prior research substantiates that the WEB has high sensitivity and specificity in identifying IPV (Coker, Pope, Smith, Sanderson, & Hussey, 2001; Smith et al., 1995). Participants were asked to indicate how much they agree or disagree with items describing their intimate relationships during their pregnancy on a 6 point-scale ranging from “strongly disagree” (1) to “strongly agree” (6). Sample items included “He made me feel unsafe, even in my home,” and “I tried not to rock the boat because I was afraid of what he might do." For each participant, a total WEB score was calculated by summing item responses. The scale was internally consistent (α = 0.93).

FHT abnormalities, unplanned cesarean delivery, and cesarean risk. Using information available in medical charts, three variables were created. FHT abnormalities and unplanned cesarean delivery were coded dichotomously (yes, no). To control for obstetrical factors and maternal characteristics that predict surgical delivery, a risk variable was constructed based on criteria recommended by obstetrics experts and used successfully in related research (e.g. Saunders et al., 2006). The risk variable was comprised of the following items from medical charts: Advanced material age (defined as ≥ 35 years old); morbid obesity (defined as BMI ≥ 40); meconium staining, preeclampsia, and gestational diabetes. Each item was coded as absent or present, and a risk score was created for each participant by counting the presence of each item.

Data Analytic Strategy

Analyses were performed using SPSS 19.0 and AMOS 18.0. Exploratory data analysis identified violation of normality by the number of major life events, pregnancy-specific distress, and WEB scores. As recommended by Tabachnick and Fidell (2007), square root, log and inverse transformations were performed on these positively skewed variables, respectively. After transformations, data met the assumptions of normality.

Structural equation modeling (SEM) was used to test the effects of PNMS and IPV on fetal distress and unplanned cesarean delivery controlling for cesarean risk. SEM was chosen for its ability to test multiple paths between observed and latent variables simultaneously. PNMS was modeled as a latent variable using pregnancy-specific distress, state anxiety, perceived stress, number of life events, and life events distress as its indicators. Psychological IPV, FHT abnormalities, risk, and unplanned cesarean delivery were included as observed measures. A double-headed arrow was included between PNMS and IPV to represent the predicted correlation between these two variables. Both PNMS and IPV were entered as predictors of FHT abnormalities and unplanned cesarean. To control for its impact, risk was included as a predictor of unplanned cesarean delivery in the model. The hypothesized model depicting direct and indirect associations is shown in Figure 3.1.

A stepwise approach was used to test the hypothesized model (Anderson & Gerbing, 1988; Newcomb, 1990). The first step involved testing the fit of the latent model of PNMS to the data using Confirmatory Factor Analysis (CFA). The following fit indices were used to evaluate model fit: the Chi-square test, normed Chi-square (CMIN/df ratio), Comparative Fit Index (CFI), and Root Mean Square Error of Approximation (RMSEA). The Chi-square test and the RMSEA tend to produce less accurate results with large sample sizes and complex models, respectively. Therefore, in addition to these indices, the normed Chi-square, and the CFI, which are insensitive to sample size and model complexity, were used to evaluate model fit (Byrne, 2009; Hu & Bentler, 1999). A non-significant Chi-square value, a CMIN/df ratio smaller than 5, a CFI value greater than .95, and an RMSEA value less than .06 with a non-significant *p* value for the test of close fit were used as indicators of good model fit (Hu & Bentler, 1999; Kline, 2005; Tabachnick & Fidell, 2007). The second step included testing the structural model of relationships among the independent and dependent variables through path analysis where each path in the model represented a specific hypothesis (Byrne, 2009).

Results

Descriptive statistics and correlations among PNMS and IPV measures are shown in Table 3.2. Similar to the findings of previous studies with pregnant women, significant, positive correlations were found among pregnancy-specific distress, state anxiety, perceived stress, number of life events, and life events distress. As expected, intimate partner violence was significantly and positively correlated with pregnancy-specific distress, perceived stress, number of life events, and life events distress. A majority of women had a vaginal birth (1,231 women, or 74.5%). Out of the 421 women who had a cesarean delivery (25.5%), 286 (67.9%) reported having an unplanned cesarean delivery. Approximately 42% of births involved FHT abnormalities, 13.5% meconium staining, 13.4% advanced maternal age, 6.2% gestational diabetes, 5.9% preeclampsia, and 3% morbid obesity.

Testing the measurement model of PNMS. The hypothesized model of PNMS initially did not fit the data well, χ^2 (5) = 155.580, p < .001; CMIN/df ratio = 31.116; CFI = .867; RMSEA = .13 (90 % CI= .12-.15; PClose = .00). Stepwise modifications were made to the model and the model fit was assessed at each step. As shown in Figure 3.2, the final model included two error covariances between the following variables: state anxiety and pregnancy-specific distress, and state anxiety and perceived stress, and exhibited good fit, χ^2 (3) = 5.765, p =.124; CMIN/df ratio = 1.922; CFI = .979; RMSEA = .02 (90 % CI = .00-.05; PClose = .929). CFA results confirmed the appropriateness of operationalizing PNMS as a single, higher order latent factor represented by pregnancy-specific distress, state anxiety, perceived stress, number of life events, and life events distress.

Testing the structural model of PNMS, IPV, and unplanned cesarean delivery. The structural model assessing associations among study variables was examined. The model exhibited good fit, χ^2 (22) = 66.758, p < .001; CMIN/df ratio = 3.034; CFI = .969; RMSEA = .03 (90 % CI = .03-.04; PClose = .995). PNMS and IPV were significantly and positively correlated (r = .36, p < .001). However, neither PNMS (β = .05, p = .108) nor IPV (β = .05, p = .079) was significantly associated with FHT abnormalities (the association of IPV with FHT, although not significant, was marginal, p < .10). Similarly, PNMS (β = .03, p = .264) and IPV (β = .01, p =.799) were not associated with unplanned cesarean delivery. However, FHT abnormalities (β = .17, $p < .001$) and maternal risk (β = .09, $p < .001$) were significant predictors of unplanned cesarean delivery.

There is some evidence that pregnancy-specific stress is a better predictor of birth outcome than a latent factor of PNMS (Lobel et al., 2000). In order to test whether pregnancy-specific stress is also a better predictor of surgical delivery, it was removed from the latent model by retaining its correlation with PNMS. Moreover, direct paths from pregnancy specific distress to FHT abnormalities and unplanned cesarean delivery were added to the model to examine whether it was an independent predictor of these outcomes (see Figure 3.3). The model was a good fit, χ^2 (20) = 87.923, $p < .001$; CMIN/df ratio = 4.396; CFI = .952; RMSEA = .04 (90 % CI = .04-.06; PClose = .770). Results revealed that pregnancy-specific distress was a significant, independent predictor of both FHT abnormalities (β = .06, $p <.05$) and unplanned cesarean delivery (β = .09, $p < .001$). Because the latent model of PNMS no longer predicted FHT abnormalities and unplanned cesarean delivery, it was removed from the model. The final model included the observed variables of pregnancy-specific distress and IPV, FHT abnormalities, and maternal risk as predictors of unplanned cesarean delivery. The model initially did not have good fit, χ^2 (3) = 23.104, $p < .001$; CMIN/df ratio = 7.701; CFI = .859; RMSEA = .06 (90 % CI= .04-.09; PClose = .148). Based on modification indices, an error covariance was added between FHT abnormalities and risk variables (see Figure 3.4). The modified model exhibited good fit, χ^2 (2) =.423, p = .809; CMIN/df ratio = .211; CFI = 1.0; RMSEA = .00 (90 % CI= .00-.03; PClose = .995). IPV was significantly and positively associated with pregnancy specific distress. Pregnancy-specific distress was a significant predictor of both FHT abnormalities (β = .07, $p <.05$) and unplanned cesarean delivery (β = .09, $p <.001$). However, IPV was not associated with FHT abnormalities (β = .04, p =.132 and unplanned cesarean delivery ($\beta = .01$, $p = .818$). Both FHT abnormalities and maternal risk remained significant predictors of unplanned cesarean delivery in the modified model ($p < .001$).

Discussion

The present study examined whether PNMS and IPV were significant predictors of fetal distress and unplanned cesarean delivery controlling for maternal risk. Fetal heart tracing abnormalities and maternal risk were significant predictors of unplanned cesarean delivery. However, neither PNMS nor IPV were associated with fetal heart tracing abnormalities and unplanned cesarean delivery.

Based on prior research, an alternative model was specified to examine whether pregnancy-specific distress was a better predictor of surgical delivery than the latent variable of PNMS. Testing the alternative model revealed that pregnancy-specific distress was significantly associated with fetal distress and unplanned surgical delivery, suggesting that it might a better predictor of unplanned cesarean delivery than a multivariate, latent model of PNMS. Findings support previous research which indicates that pregnancy-specific distress may be an especially potent type of stress (Alderdice et al., 2012; Lobel et al., 2008). For instance, pregnancy-specific distress has been shown to trigger greater physiological arousal than general stress during pregnancy (DiPietro, Hilton, Hawkins, Costigan, & Pressman, 2002; Huizink, Mulder, Robles de Medina, Visser, & Buitelaar, 2004).

The association of pregnancy-specific distress and surgical delivery may also be attributable to the particular content of the pregnancy-specific distress measure. The pregnancy experience involves unique stressors which are context specific such as concerns about physical symptoms, bodily changes, labor and delivery. Therefore, measures assessing stress specific to the pregnancy experience might be better able to capture the degree and type of stress associated with pregnancy and thereby offer more accurate and valid assessment of PNMS than general stress measures.

Study Strengths and Limitations

The present study has several strengths. First, it used a large, representative sample which increased statistical power to detect small effects. Second, use of SEM enabled the conceptualization of PNMS as a latent construct as well as the analysis of multiple paths simultaneously controlling for obstetric and maternal risk factors. Third, the study used a multivariate definition of PNMS, and enabled conclusions about its components. Finally, the study employed psychometrically robust measures of stress and partner violence, bolstering confidence in the validity of the findings.

The present study also had some limitations. First, the findings may be vulnerable to failures of memory and to recall biases. Participants were asked to report their experiences of prenatal stress and partner violence retrospectively. All interviews were conducted soon after delivery to enhance memory and minimize recall biases, however, it is possible that participants' recollections of their experiences may not be accurate, or may have been influenced by their current mood. Second, participants excluded from the present study due to lack of complete data on all study variables (mostly medical chart data) were more likely to be single, poor, less educated than the women included ($p < .001$). Therefore, findings may not be generalizable to more socioeconomically disadvantaged women. Another limitation of the study is related to how IPV was conceptualized and measured. IPV was measured by the WEB which mainly focuses on psychological abuse by a partner. IPV assessed by the WEB did not predict FHT abnormalities and unplanned cesarean delivery. However, other types of IPV, such as physical and/sexual IPV, may have stronger associations with these outcomes. Future research is needed to assess the impact of various types of IPV on the likelihood of fetal distress and surgical delivery.

Conclusion and Implications

The present study suggests the possibility of identifying pregnant women at risk for surgical delivery during the prenatal period. This effort would be valuable because prior research has shown that women having a cesarean delivery are less likely to breastfeed and interact with their babies (e.g., DiMatteo et al., 1996; Rowe-Murray & Fisher, 2001; Shawky & Abalkhail, 2003), have more negative perceptions of their birth experience, their selves, and their infant (for a review see DeLuca & Lobel, 2007), and may be at greater risk for postpartum depression (e.g., Chen & Wang, 2002) than those having a vaginal delivery. The finding that pregnancy-specific distress predicted unplanned cesarean delivery in the present study suggests that the NuPDQ might be a useful screening tool in clinical settings to identify and intervene with pregnant women at greatest risk of delivering surgically.

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Table 3.1

Participant Characteristics (N = 1,652)

	% (N) or Mean ± SD
Age at delivery	28.65 ± 5.45
Parity	0.82 ± .98
Gravidity	2.35 ± 1.47
BMI	24.86 ± 5.23
Ethnicity	
White	90 % (1377)
Black	3.6 % (60)
Asian or Pacific Islander	3.3 % (53)
Mixed race	3.1 % (52)
Education	
≤High school	16.6 % (275)
>High school	83.4 % (1377)
Marital status	
Married or cohabitating as if married	90 % (1486)
Single	7.4 % (123)
Missing	2.6 % (43)
Annual income*	Median: $ 60,000
Poor	14.5 % (240)
Near poor to low income	14.6 % (241)
Moderate income	31.8 % (525)
High income	39.1 % (646)
Employment status during pregnancy	
Employed	80.7 % (1318)
Unemployed	19.3 % (316)

* An income-poverty ratio (IPR) was calculated by dividing participants' annual household income by the number of people living with them. The following cut-off scores were used to determine income groups: *Poor* if IPR <1.0; *near poor to low income* if IPR = > 1.0 and < 2.0; *moderate income* if IPR= > 2.0 and < 4.0; *high income* if IPR = > 4.

Table 3.2

Means, Standard Deviations, and Correlations for PNMS and IPV Measures

	Correlation Coefficients					
Variables	Pregnancy Specific Distress	State Anxiety	Perceived Stress	Number of Life Events	Life Events Distress	Psychological IPV
Pregnancy Specific Distress	-	0.30**	.07*	.30**	.26**	.18**
State Anxiety		-	.13**	.08*	.11**	.04
Perceived Stress			-	.11**	.10**	.07*
Number of Life Events				-	.61**	.34**
Life Events Distress					-	.21**
Psychological IPV						-
Mean	1.45	13.19	12.6	1.42	1.38	9.52
SD	*0.11*	*3.36*	*1.63*	*0.89*	*1.03*	*1.36*

* $p < .05$, ** $p < .001$

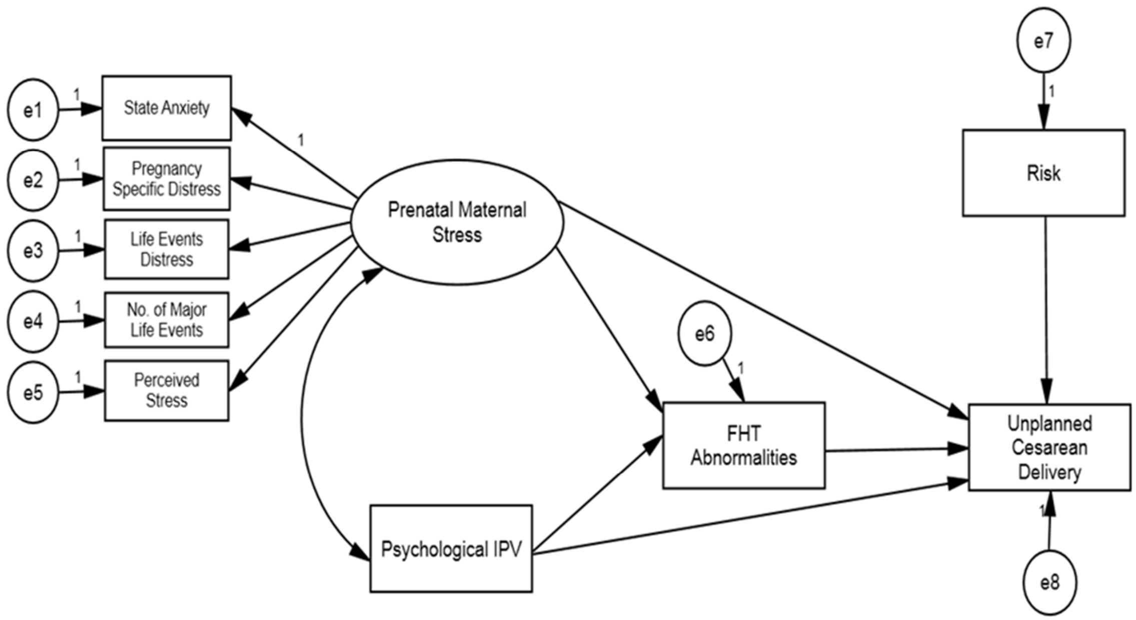

Figure 3.1. Hypothesized model depicting direct and indirect associations among PNMS, psychological IPV, FHT abnormalities, and unplanned cesarean delivery, controlling for risk.

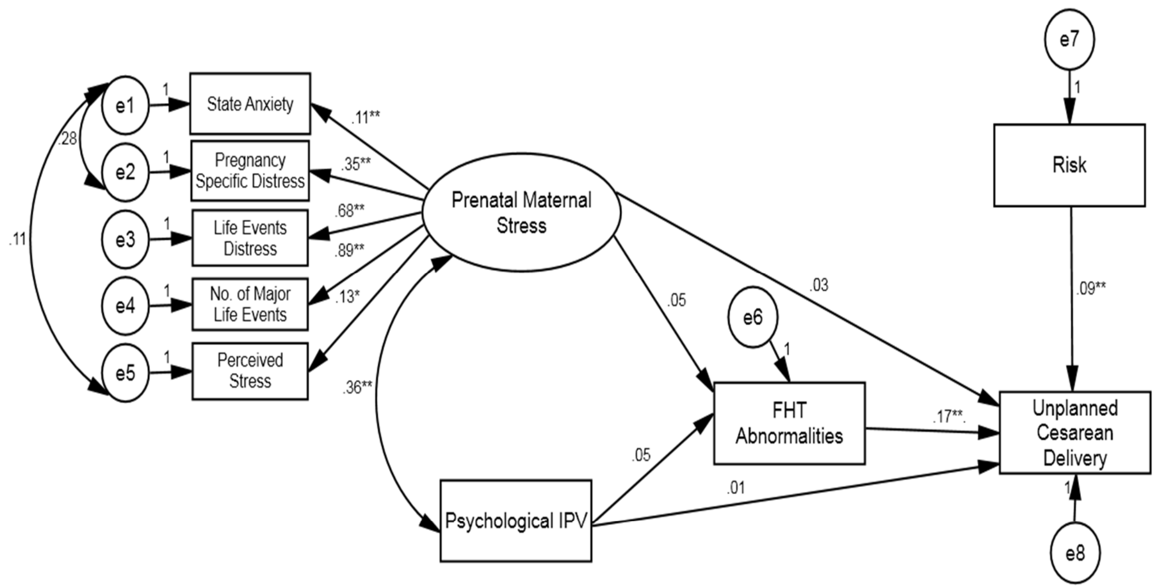

Figure 3.2. The modified model illustrating associations of PNMS, IPV, FHT abnormalities, unplanned cesarean delivery, controlling for risk. Values depict standardized path coefficient estimates (*$p < .05$; **$p < .001$).

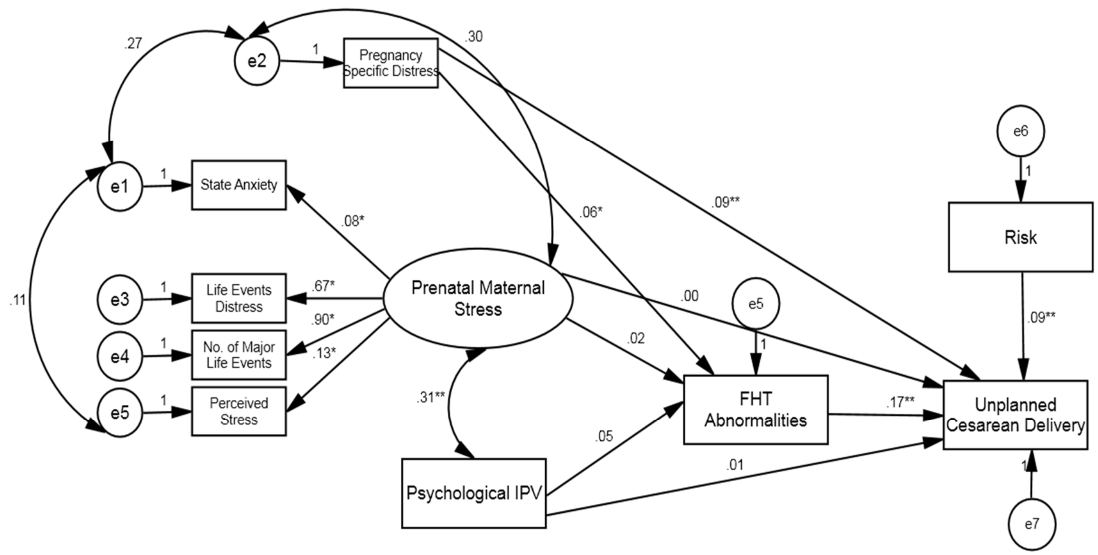

Figure 3.3. Structural equation model examining the associations of pregnancy-specific distress and IPV on FHT abnormalities and unplanned cesarean delivery with the correlation between latent PNMS and pregnancy-specific distress, controlling for risk. Values depict standardized path coefficients (**p* < .05; ***p* < .001).

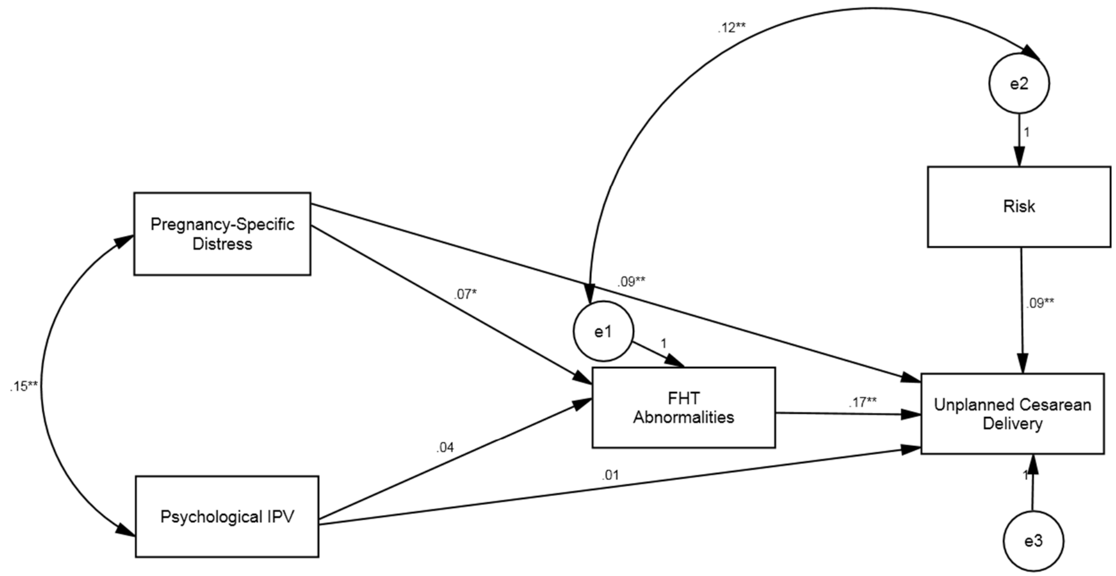

Figure 3.4. Final structural equation model examining the associations of pregnancy-specific distress and IPV on FHT abnormalities and unplanned cesarean delivery, controlling for risk. Values depict standardized path coefficients (**p* < .05; ***p* < .001).

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