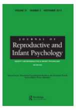

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Background: The Prenatal Distress Questionnaire (PDQ) is a short measure designed to assess specific worries and concerns related to pregnancy. The aim of this study was to confirm the factor structure of the PDQ in a group of pregnant women with a small for gestational age infant (< 10th centile). **Methods:** The first PDQ assessment for each of 337 pregnant women participating in the Prospective Observational Trial to Optimise paediatric health (PORTO) study was analysed. All women enrolled in the study were identified as having a small for gestational age foetus (< 10th centile), thus representing an 'elevated risk' group. Data were analysed using confirmatory factor analysis (CFA). Three models of the PDQ were evaluated and compared in the current study: a theoretical uni-dimensional measurement model, a bi-dimensional model, and a three-factor model solution. **Results:** The three-factor model offered the best fit to the data while maintaining sound theoretical grounds(χ^2 (51df) = 128.52; CFI = 0.97; TLI = 0.96; RMSEA = 0.07). Factor 1 contained items reflecting concerns about birth and the baby, factor 2 concerns about physical symptoms and body image and factor 3 concerns about emotions and relationships. **Conclusions:** CFA confirmed that the three-factor model provided the best fit, with the items in each factor reflecting the findings of an earlier exploratory data analysis.

Keywords: pregnancy; psychosocial factors; quantitative methods

Introduction

Over the past few decades, researchers in the perinatal field have argued for a multi-dimensional model of prenatal maternal stress assessing general and pregnancy-specific stressors, appraisals and responses as a framework by which to review and analyse research (Lobel & Dunkel Schetter, 1990). This approach has

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demonstrated that both general stress measures and pregnancy-specific stress measures have been found to predict preterm birth (Arck, 2010; Coussons-Read et al., 2012; Dunkel Schetter & Glynn, 2010) and other adverse pregnancy outcomes including poorer neonatal neurobehavioural outcomes (Talge, Neal, & Glover, 2007) and social developmental outcomes (Wadhwa, 2005). Furthermore, Lobel et al. (2008) suggest that pregnancy-specific stress may be a more potent type of stress than general stress and such measures may be more reliable predictors of preterm birth (Dunkel Schetter & Glynn, 2010). Robust measurement of pregnancy-specific well-being is needed to consolidate findings and to ensure the rigor of the research moving forward.

Pregnancy-specific stress as a construct builds on the knowledge that pregnant women are concerned about the significance of physical symptoms, changes in appearance, and changes in interpersonal relationships, labour, delivery, parenting and the health of the foetus (Alderdice, Lynn, & Lobel, 2012). Alderdice et al.'s (2012) review of pregnancy specific stress measures identified 15 measures and documented their strengths and limitations based on published reliability and data. While a considerable amount of psychometric data on these measures is now accumulating, there has been limited exploration of theoretical underpinning and the quality and quantity of reported reliability and validity data are highly variable. The consensus statement from this edition (Alderdice et al., 2013) and the reporting standards paper (Martin & Savage-McGlynn, 2013) highlight the importance of transparency and clarity when developing measures of psychological health. This is critically important, as the assumption that a measure developed and evaluated in one clinical group has similar psychometric properties in another group is often unsupported by systematic investigation of the psychometric properties of the tool (Jomeen & Martin, 2004).

Psychometric properties of the Prenatal Distress Questionnaire

The 12-item Prenatal Distress Questionnaire (PDQ) was first reported by Yali and Lobel (1999). The scale was created based on the research literature at that time and pilot tested in a small sample of pregnant women. The PDQ was designed to assess specific worries and concerns pertaining to pregnancy and includes items on concerns regarding medical problems, physical symptoms, parenting, relationships, bodily changes, labour and delivery, and the health of the baby (Yali & Lobel, 1999). It has good face validity, and can be completed in less than 5 min. Reported reliability and validity data for the original scales can be found in five studies: three conducted in the USA, one in Germany and one in the UK (Gennaro, Shults, & Garry, 2008; Lobel, DeVincent, Kaminer, & Meyer, 2000; Lynn, Alderdice, Crealey, & McElnay, 2011; Pluess, Bolten, Pirke, & Hellhammer, 2010; Yali & Lobel, 1999). It has been tested primarily on Caucasian and European study populations including primiparous and multiparous women, low and high SES and medically low- and high-risk (Lobel et al., 2000; Lynn et al., 2011; Pleuss et al., 2010; Yali & Lobel, 1999) and a sample of Black women with singleton low-risk pregnancy (Gennaro et al., 2008).

The Cronbach's alpha for the overall PDQ score has been consistently reported to be between 0.80 and 0.81 (Lobel et al., 2000; Lynn et al., 2011; Pleuss et al., 2010; Yali & Lobel, 1999). Test–retest reliability was reported in one study to be r = 0.75 (Pleuss et al., 2010). The PDQ has been found to have good convergent validity being significantly correlated with general stress measures (State Trait Anxiety Inventory – State Scale, Life Event Stress and Perceived Stress Scale). Reported correlations with other measures were highly significant but low enough to confirm that PDQ scores are not simply attributable to general stress or a predisposition to anxiety (between r = 0.35 and 0.56). Alderdice and Lynn (2011) reported on its construct validity in a sample of low-risk women identifying three factors: factor 1 reflecting concerns about giving birth and the baby (items 3, 6, 9, 10, 11, 12), factor 2 (items 1 and 7), concerns over body weight/image and factor 3 concerns over emotions and relationships (items 4, 5 and 8). Item 2 did not load on any of the factors using a 0.4 factor loading cut off.

The aim of this study was to confirm the factor structure of the PDQ in a clearly defined group of women at risk of having an infant with foetal growth restriction using robust statistical confirmatory factor-analytic methods.

Method

Study design

The PDQ data were collected as part of the Prospective Observational Trial to Optimise paediatric health (PORTO) study. PORTO is a multicentre, prospective, observational study that was conducted between January 2010 and June 2012 in the seven largest obstetric centres in Ireland. The primary aim of the PORTO study was to evaluate which sonographic findings were associated with perinatal morbidity and mortality in pregnancies affected by growth restriction, originally defined as estimated foetal weight (EFW) < 10th centile (Unterscheider et al., 2013). PDQ questionnaires were introduced to the study protocol approximately halfway through the study to six of the seven centres to provide exploratory data for further research. One centre could not recruit due to limited resources at time of data collection.

Participant

Women (1116) were recruited to the study who had an ultrasound-dated singleton pregnancies between 24^{+0} and 36^{+6} weeks gestation and an EFW < 10th percentile for gestation based on biometric measurements of the foetal head, abdomen and femur (Hadlock, Harrist, Sharman, Deter, & Park, 1985). The diagnosis was made by conventional population-based growth standards (Hadlock et al., 1985). Of the 1116 women who underwent serial sonographic assessment of biometric parameters and Doppler assessment, 337 had PDQ data available for analysis at the first observation point. The current analysis was conducted on the first PDQ assessment for each participant.

Measurement and procedure

Institutional review board approval was obtained at each centre, and participants gave written informed consent. Referral to the study occurred if small foetal size was suspected due to clinical evaluation in the antenatal setting. A PORTO Study research sonographer then confirmed that EFW was < 10th centile. At enrolment, the expectant mothers underwent health assessments which included measurement of blood pressure, height, weight, BMI, smoking and alcohol intake. Obstetric management, including foetal surveillance, was standardised across all centres. This consisted of fortnightly foetal growth and multi-vessel Doppler assessment and, if deemed necessary by the managing consultant, more frequent evaluation. The woman completed the 12 items of the PDQ by rating on a 5-point scale ranging from 'not at all worried' to 'extremely worried'. PDQ data were collected at each visit, but only data for the first visit are presented in these analyses. Fortnightly assessments continued until a decision was made to deliver which was at the individual consultant obstetrician's discretion, and was generally based on abnormal cardiotocography (CTG; measures fetal heart beat and uterine contractions) findings. Antenatal corticosteroids were given between 24^{+0} and 36^{+0} weeks gestation, if delivery was thought to be likely within one week.

Models evaluated

Three models of the PDQ were evaluated and compared in the current study: a theoretical uni-dimensional measurement model determined by a single total score and two alternative models suggested by Alderdice and Lynn's (2011) exploratory factor analysis (EFA) of the PDQ. Alderdice and Lynn (2011) found the PDQ to be a multi-dimensional instrument, comprising three factors. However, one of the identified factors comprised just two items. This presents a concern within the context of valid and reliable subscale domain as it is widely acknowledged that a factor comprising fewer than three indicators may not be sufficiently structurally or theoretically sound (Brown, 2006; Byrne, 2010).Consequently, a two-factor model was proposed by eliminating the 2-indicator factor as identified by Alderdice and Lynn (2011), resulting in a more appropriate and legitimate model of the PDQ.

Further scrutiny of Alderdice and Lynn's (2011) reported factor analysis revealed that the researchers may have been too conservative in using a factor loading cut-off criteria of 0.4, thereby dismissing a third item loading on the two-item factor with an item-factor loading of 0.3. An item-factor loading of 0.3, although modest, may indicate a legitimate item for inclusion within a scale or subscale (Matsunaga, 2010), thus this item may have been prematurely rejected in Alderdice and Lynn's (2011) original study. Therefore, a third three-factor model including this item is evaluated against the uni-dimensional model and the bi-dimensional model.

Statistical analysis

The present study utilises Structural Equation Modelling (SEM) approaches (Byrne, 2010; Kline, 2005) and in particular confirmatory factor analysis (CFA). SEM and CFA provide more robust alternative techniques to classical test theory by allowing for the investigation of relationships between observed (i.e. measured) variables and latent (i.e. unmeasured) constructs while accounting for measurement properties and error in the analyses (Embretson & Reise, 2000).

SEM and CFA represent parametric techniques, and as such, the assumptions that define parametric acceptability criteria such as multivariate normality and normal distribution, absence of outliers and interval level of measurement apply. Parametric tests are recognised as being robust against violations of parametric assumptions (Martin & Thompson, 2000) and consequently the use of these approaches with questionnaire data is not uncommon. More recent SEM software can accommodate both ordinal-level data and non-normal data as well as categorical and continuous data within the statistical analyses in order to produce robust findings. Due to the categorical nature of the PDQ data, a robust Weighted Least Squares with Means and Variances estimation method was chosen. The WLSMV is a full information estimator that assesses how well the factor solution is able to replicate the relationships among the indicators in the input matrix (Brown, 2006). Another key advantage of this estimator is that it also provides a complement of fit indices to guide further model specification.

Consistent with convention, multiple goodness-of-fit tests were used to evaluate the factor models (Bentler & Bonett, 1980): The comparative fit index (CFI) (Bentler, 1990), the Tucker–Lewis Index (TLI) (Tucker & Lewis, 1973), the Root Mean Squared Error of Approximation (RMSEA), and the Weighted Root Mean Residual (WRMR) (Muthén & Muthén, 1998–2012). According to Brown (2006) and Hu and Bentler (1999), the following are suggested guidelines for the evaluation of model goodness-of-fit: CFI > 0.95; TLI > 0.95; RMSEA < 0.06.

In addition, a statistically significant χ^2 value is indicative of a significant proportion of variance within the data being unexplained by the model (Bentler & Bonett, 1980). However, inconsequential variations in data and sensitivity to sample size often promote a significant χ^2 likelihood test statistic. This detracts from its reliability as an indicator of model fit and should therefore be interpreted with caution (Brown, 2006; Hu & Bentler, 1995). In view of this, model evaluation is generally determined by model fits statistics such as CFI, TLI and RMSEA (Byrne, 2010). It should be noted that the goodness-of-fit criteria guidelines indicated above are guidelines for the evaluation of model fit, and are not absolute. Values of these indices have been found to fluctuate as a function of modelling conditions, and therefore, values that are slightly outside of the suggested ranges may still be considered acceptable (Brown, 2006; Hu & Bentler, 1999). Decisions about model fit should be ultimately led by the data supported by theoretical underpinnings. Statistical analysis was conducted using Mplus version 7.1 (Muthén & Muthén, 2013).

Results

Three hundred and thirty-seven women completed PDQs at their first visit. They were predominantly white European (n = 285; 85%), with a mean maternal age of 29.90 (SD 5.64) and a mean gestational age at delivery of 38.17 (SD 2.72) weeks. The gestation age at study enrollment was 29.60 (SD 4.01) weeks and the mean gestational age at time of completing the questionnaire was 31.77 (SD 4.13). Maternal characteristics were similar to the larger study sample reported in Unterscheider et al. (2013).

The findings from the three CFA's conducted are summarised in Table 1. A comparison of the fit of each of the three models showed that the three-factor model offered the best fit to the data while maintaining sound theoretical grounds.

The item-factor loading of the best-fit model are summarised in Table 2. Factor 1 contained items reflecting concerns about birth and the baby, factor 2 concerns about physical symptoms and body image and factor 3 concerns about emotions and relationships.

Factor loadings may be considered to represent the 'amount' of the latent trait measured by an item, where the latent trait is an underlying, abstract construct not easily measured or quantified. The items with the largest factor loadings in each factor can be thought to have more of the latent trait than those items with lower

Table 1. Model fit statistics of the three models evaluated by CFA.

Model	χ^2	Df	CFI	TLI	RMSEA
1-factor	310.20	54	0.89	0.86	0.12
2-factor	173.10	53	0.95	0.94	0.08
3-factor	128.52	51	0.97	0.96	0.07

factor loadings. In Factor 1, items 9 and 11 had the greatest factor loading, both tapping into the underlying construct of having concerns about giving birth to an unhealthy child. In Factor 2, item 7 measures the latent construct of size and shape during pregnancy much more strongly than item 2. Similarly for Factor 3, item 8 is a much stronger measure of the underlying latent construct of this factor with a factor loading of 0.90 in comparison to item 4 with a factor loading of 0.68.

Discussion

CFA confirmed that the three-factor structure provided the best fit, with the items in each factor reflecting that of the original EFA (Alderdice & Lynn, 2011). Factor 2 had been the weakest factor in the EFA, with only two items (items 1 and 7) when the 0.4 cut-off was used. However, in the CFA, the item factor loadings were stronger, resulting in a more robust three-item third factor with all loadings greater than 0.4. These items reflect the more physical components of pregnancy reflecting weight gain and body perception and physical symptoms such as nausea and tiredness. The physical symptom item is written in a generic way to include symptoms

Table 2. Item-factor loadings of the three-factor model.

	Item	Factor loading
Factor 1 by	3. I am worried about handling the infant when I first come home from the hospital	0.65
	6. I am worried about eating healthy foods and a balanced diet for the infant	0.59
	9. I worry about having an unhealthy infant	0.75
	10. I am anxious about labour and childbirth	0.67
	11. The possibility of premature childbirth frightens me	0.71
	12. I am worried that I might not become emotionally attached to the infant	0.70
Factor 2 by	1. I find weight gain during pregnancy troubling	0.70
	2. Physical symptoms of pregnancy, such as nausea, vomiting, swollen feet or backache, irritate me	0.48
	7. Overall, the changes in my body shape and size during pregnancy bothers me	0.85
Factor 3 by	4. Emotional ups and downs during pregnancy annoy me	0.68
	5. I am troubled that my relationships with other people important to me are changing due to my pregnancy	0.73
	8. I am concerned that having a new infant will alter my relationship with the infant's father	0.90

at different stages of pregnancy, e.g. vomiting, in trimester one, or backache later in pregnancy, so it has relevance at all time points. Overall, the factor structure is theoretically coherent, but two of the factors have three items each and may benefit from additional items to consolidate the subscales.

Being able to analyse these subscales, in addition to an overall summary score, provides valuable information on what exactly it is about pregnancy that upsets women. At a clinical level these subscales provide valuable information to aid discussion with women and ultimately to identify if women may benefit from additional support in relation to more specific aspects of their pregnancy that may be causing them significant distress.

Yali and Lobel (2002) revised the scale for use in interview format and this version has been used in two other studies (Cussons-Read et al., 2012; Lobel et al., 2008). However, the revision was not based on the factor structure of the PDQ but rather on the recognition that some items later in pregnancy may not be relevant to women in early pregnancy. The revised PDQ includes nine items administered at any time point in pregnancy plus unique items added to the second and third interviews to assess issues that become more relevant as pregnancy progresses. This CFA analysis suggests that the original PDQ has a robust theoretical underpinning with three factors reflecting key concerns of women during pregnancy. The structures are also consistent, and in most cases more comprehensive, than other pregnancy-specific measures that are reviewed in Alderdice et al. (2012).

Limitations

While the sample size was sufficient for the proposed analyses, there are a number of limitations that could impact on the generalisability of the findings. The sample was a clearly defined high-risk group of women, from mainly a white ethnic group. More research is needed on women from different cultural and ethnic groups. The analysis reflected only one time point and no other measures of stress or anxiety were included to assess concurrent validity. Replications of this work might benefit from a longitudinal analytic approach that used multiple measures of stress and anxiety at different points throughout pregnancy. Also, further work comparing high- and low-risk groups on the factor structure using multiple groups CFA would provide valuable insights. For example, by exploring measurement invariance we could identify whether the items mean different things to different people based on their risk category, which in turn, influences how they respond.

Conclusions

The three-factor structure identified in an earlier EFA using a low-risk population has been replicated in this CFA with a high-risk sample. The analyses suggest that the scale has three theoretically meaningful subscales: concerns about birth and the baby, concerns about physical symptoms/body image and concerns about emotions and relationships that has been demonstrated in both low- and high-risk pregnant populations. Use of these subscales would facilitate identification of potential sources of stress for women during pregnancy and could be considered for use as an outcome measure in studies aiming to identify effective interventions to reduce stress in pregnancy or in studies exploring causal relationships between stress in pregnancy and adverse pregnancy outcomes. Also, the PDQ is short and easy to use and merits consideration for use in clinical practice pending further research.

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