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Maternal prenatal stress and infant birth weight and gestational age: A meta-analysis of prospective studies

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ABSTRACT

The present meta-analysis addresses the relation between maternal prenatal stress (MPS) and infant birth weight and gestational age in 88 prospective studies (N = 5,889,930) published between 1970 and 2012. The results suggest that this relation is significant (d = –.12; 95% CI: –.17, –.08). Three factors moderated overall effect size: 1) The type of MPS assessment: Pregnancy-related stress and anxiety yielded greater effect sizes (d = –.25; 95% CI:–.32, –.18; k = 22) than trait-based assessments (d = –.13; 95% CI:–.22, –.03; k = 22), life event measures (d = –.03; 95% CI:–.05, –.01; k = 55) or exposure to natural disasters (d = –.11; 95% CI:–.21, –.02; k = 24). Both state (d = –.14; 95% CI:–.25, –.03; k = 82) and trait MPS assessments yielded greater effect sizes than life event measures of stress; 2) studies involving high-risk samples tended to yield greater associations (d = –.26; 95% CI: –.44, –.09; k = 16) than those involving low-risk groups (d = –.08; 95% CI: –.13, .04; k = 72); 3) studies conducted outside of North America (d = –.01; 95% CI: –.14, –.06; k = 50) or Europe (d = –.06; 95% CI: –.12, –.01; k = 31) yielded greater effect sizes (d = –.70; 95% CI: –1.14, –.24; k = 7). Discussion focuses on the need to identify the kinds of stress

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most related to birth outcome, as well as the biological and environmental contexts that serve to mediate this relation.

Introduction

Among the lines of research being investigated within the scope of the Foetal Programming Hypothesis (FPH) is the relation between maternal prenatal stress (MPS) and infant birth outcome (Beijers, Buitelaar, & de Weerth, 2014). This association has been widely documented in animal studies where exposure of pregnant females to different kinds of stressors has been shown to cause adverse effects throughout development. Associations have been found between MPS and delayed intrauterine growth, gestational age, infant stress response, and motor and cognitive development problems in exposed offspring (see Weinstock, 2008 for a review).

The validity of the FPH with respect to the potential impact of MPS on birth characteristics has been investigated in humans as well. This has been an important relation to document due to the association between infant birth status, infant health and later development (Bernier, Jarry-Boileau, Tarabulsy, & Miljkovitch, 2010; Entringer, Buss, Andersen, Chicz-Demet, & Wadhwa, 2011; Keenan, Sheffield, & Boeldt, 2007) and because such birth characteristics remain relatively uninfluenced by postnatal factors that may also shape development (Bergman, Sarkar, Glover, & O'Connor, 2010). The most frequently investigated association has been that between MPS and birth weight and/or gestional age. Some scholars have observed a significant relationship between high levels of MPS and delayed intrauterine growth (Goldenberg et al., 1991), while others have found that the presence of trait anxiety is linked to lower birth weight (Kalil, Gruber, Conley, & LaGrandeur, 1995). Other studies have found associations between diverse measures of MPS and gestational age. Lobel et al. (2008) found an association between pregnancy-related anxiety and gestational age, while Rini, Dunkel-Schetter, Wadhwa, and Sandman (1999) reported a similar association between a measure of state-stress and the same outcome. These studies often controlled for different socioeconomic variables and obstetrical risk, lending credence to the observed findings. Some authors controlled for other variables such as maternal characteristics (social support, personal traits, attitudes towards pregnancy) and maternal behaviours during pregnancy (tobacco and alcohol consumption, nutrition, physical exercise; Wadhwa, 2005). Taken together, the results of these studies have contributed to the growing consensus that there is a relation between MPS and basic indicators of birth outcome.

Several mechanisms have been postulated to account for the relation between MPS and birth outcome, most recently reviewed by Beijers, Buitelaar and de Weerth (2014). The most frequently cited mechanism involves the HPA-axis activity, which would increase both intrauterine and foetal cortisol concentrations (see also Zijlmans, Riksen-Walraven, & de Weerth, 2015). However other mechanisms may mediate the MPS–birth outcome relation. These include the ways in which MPS may affect basic pregnancy care and regulatory behaviours such as sleep, and intestinal activity, the activity of the sympatho-adrenomedullary system which regulates response to acute stress and return to homeostasis, as well as immune system activity. Moreover, recent research on behaviour genetics suggests that the mechanisms linking MPS and outcome may be under some genetic influence. In this regard, it is noteworthy that almost all research on MPS is not genetically informed (Beijers et al., 2014).

However, the growing consensus surrounding the MPS–birth outcome relation has masked the fact that research results have been mixed, and that effect sizes have varied greatly. Some have even found a positive correlation between prenatal stress exposure and birth outcome (Barbosa, 2000; Bhagwanani, Seagraves, Dierker, & Lax, 1997; Field et al., 2010; McCool, Dorn, & Susman, 1994; Newton & Hunt, 1984; Perkin, Bland, Peacock, & Anderson, 1993; Ponirakis, Susman, & Stifter, 1998). Such findings have led scholars to ponder the potential biological mechanisms that may underlie a positive association between MPS and birth weight or gestational age, leading some to consider the measure and the source of stress that are involved (Talge, Neal, & Glover, 2007). Others have suggested that the trimester of pregnancy when MPS is measured is important to consider. Processes related to the secretion of high levels of cortisol in the intrauterine environment may stimulate development during the first