

Original Article

Cite this article: Van Lieshout RJ, Favotto L, Ferro M, Niccols A, Saigal S, Morrison KM, and Schmidt LA (2020) The children of preterm survivors: shyness, parenting, and parental stress. *Journal of Developmental Origins of Health and Disease* **11**: 410–414. doi: [10.1017/S2040174419000692](https://doi.org/10.1017/S2040174419000692)

Received: 1 May 2019

Revised: 26 August 2019

Accepted: 17 September 2019

First published online: 17 October 2019

Keywords:

Extremely low birth weight survivors; perinatal adversity; intergenerational transmission

Address for correspondence:

Ryan Van Lieshout, Department of Psychiatry and Behavioural Neurosciences McMaster University, St. Joseph's Healthcare Hamilton, West 5th Campus, 100 West 5th Street, Hamilton ON, L8N 3K7, Canada. Email: vanlierj@mcmaster.ca

The children of preterm survivors: shyness, parenting, and parental stress

Ryan J. Van Lieshout¹, Lindsay Favotto², Mark Ferro³, Alison Niccols¹, Saroj Saigal⁴, Katherine M. Morrison⁴ and Louis A. Schmidt⁵

¹Department of Psychiatry and Behavioural Neurosciences, McMaster University, Hamilton, Ontario Canada,

²Department of Health Research Methods, Evidence, and Impact, McMaster University, Hamilton, Ontario, Canada,

³School of Public Health and Healthy Systems, University of Waterloo, Waterloo, Ontario, Canada,

⁴Department of Pediatrics, McMaster University, Hamilton, Ontario, Canada and ⁵Department of Psychology, Neuroscience and Behaviour, McMaster University, Ontario, Canada

Abstract

Extremely low birth weight (ELBW) survivors have higher rates of shyness, a risk factor for poorer outcomes across the life span. Due to advances in fetal and neonatal medicine, the first generation of ELBW survivors have survived to adulthood and become parents. However, no studies have investigated the transmission of their stress vulnerability to their offspring. We explored this phenomenon using a population-based cohort of ELBW survivors and normal birth weight (NBW) controls. Using data from three generations, we examined whether the shyness and parenting stress of ELBW and NBW participants (Generation 2) mediated the relation between the parenting style of their parents (Generation 1) and shyness in their offspring (Generation 3), and the extent to which exposure to perinatal adversity (Generation 2) moderated this mediating effect. We found that among ELBW survivors, parenting stress (in Generation 2) mediated the relation between overprotective parenting style in Generation 1 (grandparents) and child shyness in Generation 3. These findings suggest that perinatal adversity and stress may be transmitted to the next generation in humans, as reflected in their perceptions of their children as shy and socially anxious, a personality phenotype that may subsequently place their children at risk of later mental and physical health problems.

Introduction

Due to advances occurring in fetal and neonatal medicine over the past several decades, the first generation of ELBW survivors have survived to adulthood and become parents. Even though preterm survivors appear to be more sensitive to stress and its effects^{1,2} no studies have investigated the transmission of this stress vulnerability to their offspring. It is therefore important that we understand the impact of exposure to significant perinatal adversities both for survivors and for their offspring.

Adverse early experiences can influence parenting and the transmission of personality phenotypes known to portend psychiatric risk of offspring. Indeed, previous research has shown that survivors of prematurity, particularly those born at extremely low birth weight (ELBW) have higher rates of shyness^{1,2}, a stress vulnerability factor for mental illness and other adverse health, interpersonal, and vocational outcomes across the life span^{3,4}. Until now, however, no one has had the opportunity to examine parenting among ELBW survivors and the transmission of their shy personality phenotype to their children.

Here we explore the intergenerational transmission of shyness using data from a prospectively followed cohort of ELBW survivors (<1000 g) and normal birth weight (NBW) controls at age 30–35 when many of them have become parents. We examined whether (1) shyness and parenting stress in ELBW and NBW participants (Generation 2; G2) mediated the association between the parenting style of their own parents (Generation 1; G1) and shyness in their own children (Generation 3; G3) and (2) the altered stress reactivity of ELBW/NBW parents (G2) resulting from their perinatal exposure to severe perinatal stress (i.e., ELBW birth weight status) moderated the mediating effect of their shyness and parenting stress on shyness in their children (G3) (Fig. 1).

Methods

Sample

The study sample consisted of a prospectively followed cohort of ELBW survivors born (<1000 g) in central-west Ontario, Canada, between 1977 and 1982. A total of 397 ELBW infants were recruited at birth, and of these, 179 (45%) survived to hospital discharge³. At age 8, 145 full-term, NBW children were matched to these ELBW survivors by ethnicity, sex, and familial

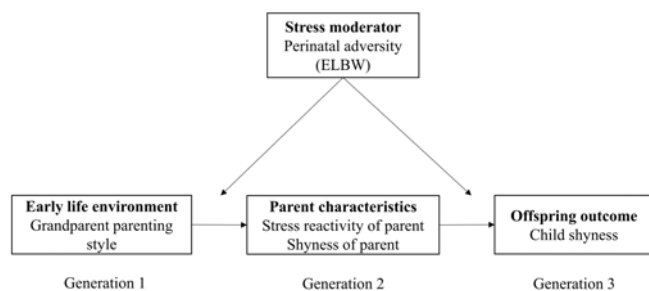


Fig. 1. Proposed intergenerational transmission of risk model for shyness.

socioeconomic status (SES; G2)⁴. Longitudinal follow-up assessments of all G2 participants took place at ages 8, 14, 22–26, and 30–35 years. Both ELBW and NBW groups participated in an identical follow-up protocol at each assessment. At the 30- to 35-year follow-up assessment, 100 ELBW survivors and 89 NBW controls participated. At this time, 45 of these participants (18 ELBW and 27 NBW) had children of their own and provided information on both their parenting stress and their child's temperament. These 45 parents had a total of 68 children (28 offspring of ELBW survivors and 40 offspring of NBW controls). The local Research Ethics Board provided ethics approval, and all participants provided written informed consent.

For the present study, grandparents or G1 comprised the parents of ELBW survivors and NBW controls, G2 comprised ELBW and NBW participants, and G3 comprised children of the ELBW and NBW participants.

Variables

Outcome: shyness in children (G3)

When they were 30–35 years old, parents (G2) completed the Colorado Child Temperament Inventory (CCTI) for each of their children (G3). The CCTI measures multiple domains of temperament, including sociability, emotionality, activity, soothability, attention span/persistence, and shyness. Each subscale comprises five items, ranging from 1 (not at all characteristic) to 5 (extremely characteristic) for a subscale score range from 5 to 25, with higher scores on the subscale representing higher levels of that temperament characteristic. Given that shyness is a personality phenotype of individuals born extremely premature, the shyness subscale was of particular interest in the present study. A sample item is “Child takes a long time to warm up to strangers.” The CCTI has good psychometric properties^{5,6}, and the shyness subscale had acceptable reliability in our sample ($\alpha = 0.63$).

Mediator 1: parenting stress in parents (G2)

The Parenting Stress Index–Short Form (PSI-SF)⁷ was completed by ELBW survivors and NBW control participants (G2) at age 30–35 and is a 36-item measure that assesses the level of stress in the parent–child unit. The PSI-SF contains three scales (a) parental distress, (b) difficult child, and (c) parent–child dysfunctional interaction as well as total parenting stress. Items are measured on a 5-point scale from strongly agree to strongly disagree, with a higher score representing greater perceived parenting stress. We used the total parenting stress score in this study, with a possible range of scores from 36 to 180. Reliability in our sample was excellent ($\alpha = 0.93$), consistent with previous research on the questionnaire's psychometric properties⁸.

Mediator 2: shyness in parents (G2)

Shyness in G2 at age 30–35 was measured using the five highest loaded shyness items⁹ of the Cheek and Buss Shyness Scale^{9–11}. Items on this scale include “I find it hard to talk to strangers” and each item is rated on a 5-point Likert scale from 0 (extremely uncharacteristic) to 4 (extremely characteristic). Higher scores indicate greater shyness. The shyness subscale has good internal consistency in our sample ($\alpha = 0.79$), in keeping with the established reliability of the measure^{9,11}.

Exposure: parenting style in grandparents (G1)

When ELBW and NBW participants (G2) were 22–26 years old, they retrospectively reported on the parenting style that their parents (G1) used during their childhood (up to age 16) by completing the parental bonding instrument¹² (PBI). The PBI is a 24-item scale with 12 items assessing overprotective parenting behavior (e.g., “let me decide things for myself”) and 12 items assessing insensitive parenting behavior (e.g., “seemed emotionally cold to me”), which are rated on a 4-point scale from 0 (very like) to 3 (very unlike). Higher total scores indicate overprotective and insensitive parenting¹³. The PBI has been shown to be a reliable and valid measure of the parenting environment¹⁴. Internal consistency in our sample was excellent ($\alpha = 0.92$).

Covariates

Maternal psychopathology and SES are known influences on the relation between parenting behavior and offspring social inhibition¹⁵. Accordingly, SES and maternal negative affect in grandparents (G1) when parents (G2) were 8 years old were considered as covariates in all analyses.

Maternal negative affect was assessed using the five negative affect items of the Bradburn Affect Balance Scale¹⁶. Higher scores indicate greater negative affect. This scale has good psychometric properties¹⁶ and had acceptable internal consistency in our sample ($\alpha = 0.62$). The Hollingshead two-factor index was used to obtain SES¹⁷. This index considers parent educational attainment and occupational prestige, and grandparents' scores were classified from 1 (high SES) to 5 (low SES).

Data analysis

Birth weight group differences were identified using *t*-tests for continuous variables and χ^2 tests for categorical variables. To examine the intergenerational transmission of shyness across the three generations, we conducted a multilevel, multiple-group path analysis controlling for clustering of responses at the family level.

The product coefficient method¹⁸ was utilized to assess the mediating effect parenting stress and shyness of parents (G2). The method of variance estimates recovery¹⁹ was utilized to determine whether path estimates for ELBW survivors significantly differed from NBW controls. All tests were two sided at $\alpha = 0.05$. Model fit was based on the following indices: goodness of fit, comparative fit index (CFI), and standardized root mean square residual (SRMR)²⁰.

Missing data

Multiple imputation (10 data sets) was used to account for data assumed to be missing at random. Data on household SES or maternal negative affect of G1 were missing for 7% of participants.

Table 1. Sample characteristics

Characteristic	Extremely low birth weight		Normal birth weight	
	n	(%)	n	(%)
Generation 3: children, n	28		40	
Male, n (%)	17	(60)	21	(52)
Age ^a , M (SD)	5.65	(3)	4.85	(4)
Birth weight, grams, M (SD)	3509.21	(650)	3317.20	(474)
Shyness, M (SD)	15.61	(2)	15.67	(2)
Generation 2: parents, n	18		27	
Number of parents				
Male, n (%)	4	(22)	7	(26)
Age at 30- to 35-year visit, M (SD)	32.81	(2)	32.70	(1)
Birth weight, grams, M (SD)	873.05*	(121)	3325.55	(443)
Gestational age, wks, M (SD)	27.44*	(3)	40.00	(0)
Parenting stress, M (SD)	70.53	(20)	63.81	(15)
Shyness, M (SD)	5.39	(5)	4.73	(4)
Married, N (%)	10	(56)	18	(67)
Number of children, M (SD)	1.56	(1)	1.54	(1)
Generation 1: grandparents, n	18		27	
Socioeconomic status, M (SD)				
I: highest SES level	0	0	1	(4)
II	1	(4)	4	(15)
III	11	(65)	11	(41)
IV	5	(29)	9	(33)
V: lowest SES level	0	0	2	(7)
Negative affect, M (SD)	1.88	(2)	2.58	(2)
Parenting style, M (SD)	16.7	(13)	17.63	(13)

* $p < 0.0001$.^aRefers to age of children at the time of 30- to 35-year follow-up of parents (G2).

Results

No statistically significant differences were found comparing sociodemographic characteristics such as age, sex, birth weight, and SES of ELBW survivors and NBW controls at any of the three generations. Further, no statistically significant differences were observed between children born to ELBW survivors and NBW control participants (Table 1).

Transmission of stress across three generations

The insensitive and overprotective parenting style of grandparents (G1) was positively associated with shyness of the children (G3) of ELBW survivors (G2), $\beta = 0.64$, 95% CI 0.41, 1.41, $p = 0.01$, but not of NBW control participants ($\beta = 0.17$, $p = 0.21$).

Mediation by parenting stress of parent (G2)

Figure 2 illustrates the relation between the parenting style of grandparents (G1), parenting stress of parents (G2), and shyness in children (G3). Birth weight of parents (G2) significantly moderated the relation between the parenting style of grandparents (G1) and parenting stress of parents (G2), $\Delta\beta = 0.58$, 95% CI 0.09, 1.07, such that overprotective and insensitive parenting of grandparents (G1)

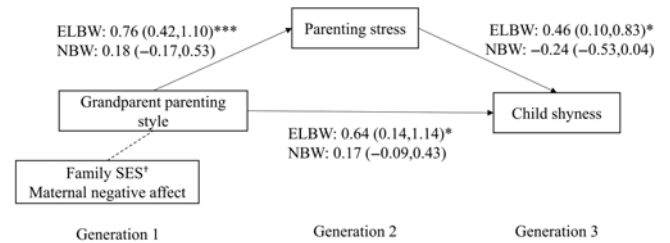


Fig. 2. Path model of the intergenerational transmission of shyness through parenting stress. Models were specified for extremely low birth weight survivors (top) and normal birth weight survivors (bottom) of Generation 2. * $p < 0.05$, ** $p < 0.01$, *** $p < 0.0001$. †Path model adjusted for family socioeconomic status (SES) and maternal negative affect when Generation 2 was 8 years of age.

predicted greater parenting stress in ELBW parents (G2) ($\beta = 0.76$, $p < 0.001$), but not NBW parents ($\beta = 0.18$, $p = 0.32$). Birth weight also moderated the relation between parenting stress of parents (G2) and shyness of children (G3) ($\Delta\beta = 0.70$, 95% CI 0.24, 1.17). As ELBW survivors experienced greater stress in their parenting role (G2), they reported greater shyness among their children (G3) ($\beta = 0.18$, $p = 0.01$), a finding that was not observed among NBW parents ($\beta = 0.15$, $p = 0.10$).

The mediating effect of parenting stress of parents (G2) on the relation between the parenting style of grandparents (G1) and shyness of children (G3) was also moderated by birth weight status, $\Delta\alpha\beta = 0.40$, 95% CI 0.06, 0.73. Parenting stress of parents (G2) mediated the relation between the parenting style of grandparents (G1) and shyness of children (G3) among ELBW survivors, $\alpha\beta = 0.35$, 95% CI 0.03, 0.67, but not among NBW control participants, $\alpha\beta = -0.04$, 95% CI -0.14 , 0.06. Therefore, among ELBW survivors, the parenting style of grandparents (G1) predicted greater stress in their children's role as parents (G2) and greater shyness among their children's children (G3). Among NBW controls, no relations were observed among the parenting style of grandparents (G1), parenting stress of parents (G2), and shyness in children (G3). Acceptable fit was achieved for this model, $\chi^2(4) = 6.4$, CFI = 0.95, SRMR = 0.05.

Mediation by shyness of parent (G2)

Figure 3 depicts the relation between the parenting style of grandparents (G1), shyness of parents (G2), and shyness of children (G3). For both ELBW and NBW parents (G2), parenting style of grandparents (G1) was not related to shyness in parents (G2) at age 30–35 (G2) (ELBW: $\beta = -0.03$, $p = 0.91$; NBW: $\beta = 0.23$, $p = 0.19$). Further, shyness in ELBW and NBW parents (G2) was not related to parent-rated shyness in children (G3) (ELBW: $\beta = -0.24$, $p = 0.26$; NBW: $\beta = -0.03$, $p = 0.18$). Shyness in parents (G2) also did not mediate the association between parenting style in grandparents (G1) and shyness in ELBW or NBW parents' offspring (G3). No relations were observed among the parenting style of grandparents (G1), shyness in parents (G2), and shyness in children (G3) among both ELBW and NBW controls. The data fit this model well, $\chi^2(4) = 3.5$, CFI = 0.99, SRMR = 0.04.

Discussion

To our knowledge, this is the first study to explore relations among perinatal adversity, parenting stress, and personality development across three generations in general, and in ELBW offspring in particular. We found that an early parenting environment that is overprotective and insensitive may influence ELBW survivors'

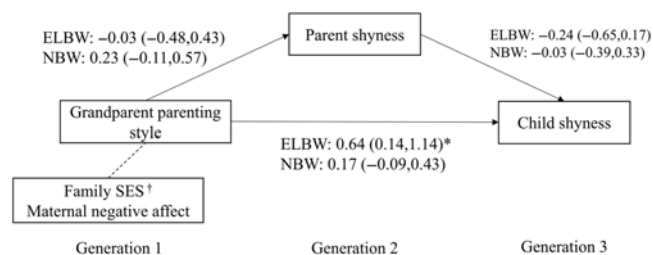


Fig. 3. Path model of the intergenerational transmission of shyness through parent shyness. Models were specified for extremely low birth weight survivors (top) and normal birth weight survivors (bottom) of Generation 2. * $p < 0.05$, ** $p < 0.01$, *** $p < 0.0001$. [†]Path model adjusted for family socioeconomic status (SES) and maternal negative affect when Generation 2 was 8 years of age.

later experience of parenting stress, and potentially negatively affects their offspring in the form of elevated levels of shyness. These findings suggest that among those who experience perinatal adversity, stress reactivity may generalize to other domains such as parenthood and may be transmitted to their offspring, reflected in their perceptions of their children as shy and socially anxious. This personality phenotype may subsequently place their offspring at risk of later psychopathology.

The findings of this study are consistent with previous work that has identified links among retrospective reports of an early life parenting environment that was harsh (G1), high maternal distress in adults (G2), and social problems in offspring (G3)²¹. Assel and colleagues (2002) did not identify an effect of prematurity, though other studies have shown that offspring who experienced added stress or vulnerability (i.e., low birth weight) are especially sensitive to the effects of overprotective and controlling parenting styles²². Overprotective and controlling parenting styles have been associated with higher levels of children's dependence on parents and lower levels of confidence in novel situations²³, so it is possible that ELBW survivors may experience reduced confidence in their later role as parents, influencing their overall parenting behaviors. In our study, even though ELBW survivors do not report significantly greater stress in their parenting role compared to NBW controls, their unique vulnerability combined with a suboptimal early parenting environment was positively related to high stress reactivity to the demands of parenthood (i.e., parenting stress), and the perception of poor competency of their children in new social situations (i.e., shyness).

Perinatal adversity is thought to induce epigenetic modifications of the hypothalamic–pituitary–adrenal axis, resulting in a heightened stress response and altered neuronal development in areas related to emotion regulation and coping^{24,25}. These early developmental changes increase vulnerability to stress and disease into adulthood^{26,27}, but no studies appear to have examined the transmission of this vulnerability to subsequent generations. Previous work has observed increased rates of behavior problems in childhood²⁸ and depression into later life²⁹ among offspring of maltreated mothers, supporting a generational impact of child abuse. However, this is the first study to observe the stress vulnerability of ELBW survivors in their offspring (i.e., social inhibition/shyness) and to support the transmission of risk to subsequent generations using another model of early life adversity.

These findings suggest that the perinatal programming of ELBW survivors (G2) may be passed on to their offspring (G3). The transmission of stress vulnerability due to perinatal adversity of the ELBW parent generation (G2) may occur through various mechanisms. Females born ELBW (G2) may continue to manifest

a heightened stress response during pregnancy³⁰. Stress-induced global histone methylation changes have also been observed in animals models in subsequent generations not exposed to stressful environments^{31,32}, and so epigenetic alterations may be inherited by G3 through germ line transmission, continuing the cycle of risk even after stress conditions have ceased.

Conversely, environmental contributors to the transmission of stress vulnerability have been proposed^{15,33} such as the early parenting environment. For example, responsive parenting of children of socially phobic biological parents interrupted the transmission of behavioral inhibition among offspring¹⁵. Parenting behaviors of ELBW parents (G2) may therefore induce postnatal epigenetic changes in the brain of their offspring during later sensitive periods of development³⁰ as well. Therefore, nongenomic behavioral transmission may induce a social stress/shyness phenotype of their offspring, supporting the continuation of a stress vulnerable phenotype among subsequent generations.

Limitations

This study has some limitations that should be discussed. First, as this study followed participants for over three decades, there has been some attrition. The current cohort comprised 68% ($n = 18$) and 67% ($n = 27$) of the original ELBW and NBW sample, respectively³⁴, with a smaller proportion (28% of ELBW survivors and 45% of NBW controls) having had children by age 30–35. This attrition resulted in a small sample size.

Second, the measures used to assess early parenting environment, parenting stress, and temperament were all completed by the same informant, that is, only one parent (G2), and so the observed effect may be inflated due to shared method variance. Furthermore, identical measures of parenting across G1 and G2 were not available, but nevertheless, we were able to demonstrate the intergenerational continuity of stress reactivity.

Third, investigators interested in using the results of this work to inform sample size calculations in future studies should be mindful of the limited sample size available in this study.

Fourth, given the concurrent assessment of variables, it is difficult to establish causal relations among them. It is possible that the reciprocal relations exist between parenting stress (G2) and child shyness (G3). Future studies should use a larger sample with multiple informants, including direct behavioral observations of parents and children, in a prospective longitudinal design to provide more robust evidence regarding the potential mechanisms of transmission of child temperament.

Conclusion

These findings have both important theoretical and practical implications. In the oldest known prospectively followed cohort of ELBW infants in the world, and the first known investigation of their offspring, we were able to test novel hypotheses regarding the intergenerational transmission of stress and the antecedents of shyness across three generations. To our knowledge, this is the first study to investigate the association among perinatal adversity, parenting, and personality development across three generations. Findings support a cycle of stress vulnerability across generations, as parenting stress of the ELBW parents (G2) mediated the relation between the parenting style of grandparents (G1) and shyness in children (G3). Thus, these findings suggest that perinatal stress may be transmitted to the next generation in humans. A three-generation approach³⁵ including support for

grandparents (parents of ELBW infants), parents (ELBW survivors), and children (offspring of ELBW survivors) could have the potential to interrupt this cycle of transmission. Continued assessment of ELBW survivors into adulthood and parenthood and of their offspring is warranted to further understand the multi-generational effects of perinatal stress on physical and emotional well-being and to develop interventions aimed at optimizing the health and success of children and families.

Acknowledgements. The authors thank all the study participants and their families as well as Mr. Calan Savoy for his assistance with manuscript preparation.

Financial support. All phases of this study were supported by Canadian Institutes of Health Research grants CIHR: TMH-103145 (to L.A.S.) and CIHR: MOP42536 (to S.S.) and National Institute of Child Health and Human Development grant NICHD: 1-R01HD40219 (to S.S.). All funding sources did not have a role in the study design, collection, analysis, or interpretation of the data; the writing of the manuscript; or the decision to submit the manuscript for publication.

Conflicts of interest. None

Ethical standards. The authors assert that all procedures contributing to this work comply with the Tri-Council Policy Statement of Ethical Conduct for Research Involving Humans and with the Helsinki Declaration of 1975 and have been approved by the Hamilton Integrated Ethics Review Board (HiREB).

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