Research Article

Lipid Profiles at Birth Predict Teacher-Rated Child Emotional and Social Development 5 Years Later

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Abstract
The fetal environment has been increasingly implicated in later psychological health, but the role of lipids is unknown. Drawing on the ethnically diverse Born in Bradford (BiB) birth cohort, the current study related levels of high-density lipoprotein (HDL), very-low-density lipoprotein (VLDL), and triglycerides in umbilical cord blood to 1,369 children's teacher-rated psychosocial competence approximately 5 years later. Results of ordinal logistic regressions indicated that low levels of HDL, high levels of VLDL, and high levels of triglycerides predicted greater likelihood of being rated as less competent in domains of emotion regulation, self-awareness, and interpersonal functioning. Furthermore, these results generalized across ethnic background and children's sex and were not accounted for by variables reflecting mothers' psychological or physical health, children's physical health, or children's special education status. Together, these results identify fetal exposure to anomalous lipid levels as a possible contributor to subsequent psychological health and social functioning.

Keywords
fetal development, cholesterol, triglycerides, emotion regulation, psychological health

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Scientists have long recognized the importance of fetal development for subsequent physical disease (DiFranza, Aligne, & Weitzman, 2004; Hernández-Díaz, Werler, Walker, & Mitchell, 2000). Recently, however, there has been a growing appreciation of the influence of this period on psychological health. For example, elevated placental levels of corticotrophin-releasing hormone predict higher internalizing symptoms in children at the age of 5 years (Howland, Sandman, Glynn, Crippen, & Davis, 2016). Similarly, exposures to lead, alcohol, folate deficiency, chronic stress, and infection during gestation are linked to negative psychological outcomes in offspring, including intellectual disability, attention-deficit/hyperactivity disorder, and schizophrenia (Ellman, Yolken, Buka, Torrey, & Cannon, 2009; Hu et al., 2006; Mattson, Riley, Gramling, Delis, & Jones, 1997; Roza et al., 2010). Indeed, as cells differentiate, canalize, and proliferate across gestation, it is not surprising that a developing fetus would be especially responsive to intra- and extracellular signals during this period and that such effects might become biologically embedded in ways that contribute to later mental health.

In the current study, we tested the formulation that anomalous levels of lipids in umbilical cord blood (which is fetal in origin) is related to subsequent psychological functioning. Briefly, lipids, including cholesterol and triglycerides, are fat molecules that play important roles in energy transport and storage, cell signaling, and maintaining membrane integrity (Olson, 1998). Scientists measuring cholesterol in humans typically further distinguish between "good cholesterol" that protects against risk—levels of high-density lipoproteins (HDLs) that remove fat from artery walls and reduce macrophage accumulation—and "bad cholesterol" that contributes to risk—levels of low-density lipoproteins

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(LDLs) or very-low-density lipoproteins (VLDLs) that are involved in fat delivery and contribute to atherosclerosis. Although these lipid markers are implicated reliably in physical health (Shimizu, 2009), it is not clear whether low fetal levels of HDLs or high levels of LDLs, VLDLs, or triglycerides also have enduring effects on psychological health.

Researchers assessing adults have documented connections between lipids and several psychological phenomena. For example, studies drawing on Italian and Korean cohorts report associations between blood lipid levels and personality traits, finding low HDL to be associated with higher levels of Neuroticism and high levels of triglycerides to be correlated with low Extraversion and Conscientiousness (Roh et al., 2014; Sutin et al., 2010). Other investigators have found that high VLDL is associated with a history of suicide attempts (Baek et al., 2014) and that elevated triglycerides relate to higher symptoms of depression and anxiety (Igna, Julkunen, & Vanhanen, 2011).

Notably, many researchers posit a model in which psychological traits lead to alterations in lipid profiles, rather than the reverse (Johnson, Collier, Nazzaro, & Gilbert, 1992). Although a few studies support this direction of effects (Floyd, Mikkelson, Hesse, & Pauley, 2007; Todaro, Shen, Niaura, Spiro, & Ward, 2003), several prospective longitudinal studies suggest the reverse: that lipid profiles predict subsequent psychological functioning. For example, Raikkonen, Matthews, and Kuller (2002) reported reciprocal associations between psychological states and metabolic syndrome (characterized by high total cholesterol, triglycerides, and other cardiovascular markers) in adults and found, in part, that metabolic syndrome at baseline predicted increasing levels of anger and anxiety over time. In addition, among psychiatric inpatients, low HDL or high total cholesterol and triglycerides have been found to predict violence and aggressive behavior, self-injury, and risk for repeated suicide attempts (Emet et al., 2015; Eriksen, Bjørkly, Lockertsen Færden, & Roaldset, 2017; Roaldset, Bakken, & Bjørkly, 2011). Finally, in a community sample of over 400,000 individuals, low HDL predicted the onset of mood disorders over a 2-year period (Kim, Han, Jang, & Park, 2018). Together, this work increasingly implicates lipid markers in psychological health.

Although specific biological cascades that account for such associations are not yet clear, lipids are involved in the regulation of several interrelated systems relevant to psychiatric functioning, including brain development, inflammation, serotonergic systems, and neuroendocrine responses (Huang & Chen, 2005), suggesting multiple plausible and overlapping pathways through which lipids may relate to psychological health. Despite these accumulating findings, little work has considered associations between lipids and psychological functioning in children, and no research has examined lipid profiles in the fetal stage, a period when developing biological systems may be particularly sensitive. Such an investigation would permit stronger directional inferences and may identify modifiable risk processes that are relevant to subsequent psychological health.

To this end, we utilized a large, ethnically diverse birth cohort in the current study to examine prospective associations between fetal lipids and subsequent psychological and social functioning at the age of approximately 5 years. We examined broadly defined socioemotional competency, as rates of psychopathology are likely to be low in young children. We also tested the generalizability of associations, as well as whether other psychological or physical health variables in mothers or children are confounders that could have accounted for the results. Specifically, reflecting patterns in prior psychological work and the respective risk-protective function of HDL versus the risk-promotive functions of VLDL and triglycerides for metabolic health, we hypothesized that lower levels of HDL, higher levels of VLDL, and higher levels of triglycerides in umbilical cord blood at birth would each predict a greater likelihood of children being rated by their teachers as less socially and emotionally competent 5 years later. We also examined whether the observed associations were consistent for male and female children and across ethnic backgrounds. Finally, we tested whether maternal psychological or physical health during pregnancy, maternal use of prenatal vitamins, and children's physical health, body mass index (BMI), or special education status accounted for the study findings.

Method

Overview

As part of the large, ongoing, multiwave Born in Bradford (BiB) cohort study, pregnant women who were between 26 and 28 weeks of gestation were recruited between March 2007 and December 2010 through the Bradford Royal Infirmary (Bryant et al., 2013; J. Wright et al., 2013). Ethics approval for the study was granted by Bradford National Health Service Research Ethics Committee (Reference No. 06/Q1202/48; see Raynor & Born in Bradford Collaborative Group, 2008, for more detailed information about recruitment and study protocol). The following variables were pertinent to the present study: demographic factors, maternal depressive symptoms, use of prenatal vitamins, and medical health records of the mother during pregnancy; cord blood collected at the birth of the child; general physical health of the child rated by the mother when the child was 3 years of age; the child's psychosocial competences, as rated by teachers at the end of his or her reception year[1] when the child was approximately 4 to 5 years old; and the child's BMI relative to the British population at approximately 5 years old. All data were collected by trained researchers, physicians, and staff using the participants' preferred language of communication.

Participants

Various components of the larger BiB study were administered to different subsets of participants; for the current study, 1,369 children and their mothers had complete data on variables central to the present analyses. Mothers included in this study were 27.60 years of age at recruitment (SD = 5.42), and 52% of the children were male. Reflecting the unique ethnic composition of Bradford, England, 37.9% of the sample was White British, 51.1% was Pakistani British, and 11.0% was of another ethnic background. Average family income was in the second decile of British incomes based on 2007 data, and on average, mothers had completed their Graduate Certificate of Secondary Education or equivalent.

Compared with participants from the larger study who had missing data but who provided a response to at least one variable before children were 5 years old, individuals included in the current sample were less likely to be Pakistani British and had lower average maternal educational attainment (education category: M = 2.40 vs. M = 2.49) and lower average income (income decile: M = 2.40 vs. M = 2.50). There were no other significant differences between individuals included in the current study and those excluded because of missing data on any study variables.

Measures collected at pregnancy

Prenatal maternal depression. At the baseline assessment conducted at approximately 27 weeks of gestation, pregnant women completed the depression subscale of the General Health Questionnaire–28 (Goldberg & Hillier, 1979), a widely used mental health screening instrument with demonstrated validity and reliability (Goldberg et al., 1997). The present study included seven items assessing recent depressive symptoms, each rated on a 4-point scale ranging from *better than usual* to *worse than usual*. Sample items include "have you recently felt that life was entirely hopeless?" and "have you recently been thinking of yourself as a worthless person?" Internal reliability was high (α = .86).

Maternal physical health. At study entry, mothers' medical records were coded for history of diabetes, history of hypertension, and gestational diabetes (yes/no).

Maternal use of prenatal vitamins. During the baseline questionnaire in pregnancy, mothers reported on how frequently they took PrenaCare multivitamins during pregnancy—a prenatal supplement. Responses were reverse coded so that higher scores would reflect more frequent use. Scores ranged from 0 to 5: 5 (*daily*), 4 (*5–6 times per week*), 3 (*2–4 times per week*), 2 (*once a week*), 1 (*less often*). A 0 reflected that the item was left blank, which was interpreted as indicating that mothers did not use this vitamin at all. Although this interpretation of nonresponses as reflecting nonuse is not methodologically ideal, it is supported by the fact that the level of nonresponse to this item was profoundly higher than to items before or after it in the questionnaire packet.

Demographic covariates. Information about participants' age, education, and ethnic background was also collected.

Measures collected at birth

Unlike the placenta (which contains a mixture of maternal and fetal cells), cord blood cells are fetal in origin and thus provide an index of the developing fetus through relatively noninvasive means (Needham et al., 2011). Umbilical cord blood samples were obtained at delivery by the attending midwife and were refrigerated at 4° C in ethylenediaminetetraacetic acid (EDTA) tubes until being spun, frozen, and stored at −80° C. Samples were transferred to the Biochemistry Department of Glasgow Royal Infirmary for analysis. HDL, VLDL, and triglyceride levels were assayed using commercially available automated enzymatic methods with the ARCHITECT *c*System (Abbott, Abbott Park, Illinois).

Measures collected at 3 years

When children were 36 months of age, mothers responded to the item "Describe your child's health" on a 5-point scale ranging from *excellent* to *poor*.

Measures collected at 4 to 5 years

Child psychosocial competence. At the end of reception year (when children were 4–5 years old), children's teachers rated each child's psychosocial competencies using the 2013 version of the Early Years Foundation Stage Profile (Department for Education, 2012), a standardized academic development tool that has been adopted as a mandatory assessment in all Bradford schools. As part of the Personality, Social Development, and Emotion section, children were rated on their development in domains relating to self-awareness (Self-Confidence and Self-Awareness subscale), emotion regulation (Managing Feelings and Behaviour subscale), and interpersonal relationships (Making Relationships subscale). For each domain, children were classified as being below developmental expectations ("emerging"), at developmental expectations ("achieving"), or exceeding developmental expectations ("exceeding") on the basis of the teachers' assessments after a year of working with the children. (We excluded nine children from the larger study who were noted as being absent for long periods or who recently moved to the area.)

Special needs status. As part of the academic assessment at ages 4 to 5, each child was coded as either being in or not being in special education.

Children's BMI. As part of the National Child Measurement Programme, all children had their height and weight recorded, along with their age in months, during reception year. Scores were standardized relative to the British 1990 growth reference (UK90; C. M. Wright et al., 2002), which is the most common reference value used in England for population monitoring.

Data-analysis plan

To examine whether lipid markers predict social and emotional development, we conducted ordinal logistic regressions using a generalized linear model. We modeled children's developmental competency (below, at, or exceeding developmental expectations) in the domains of self-awareness, emotion regulation, and interpersonal functioning separately by cord blood HDL, VLDL, and triglycerides, controlling for maternal age at baseline, ethnic background, children's sex, and maternal education level, resulting in a total of nine models. Following prior work, we ran these models separately (with one lipid marker predicting one psychosocial marker) to acknowledge the unique biological functions of HDL, VLDL, and triglycerides and to also provide a test of consistency across conceptually related, but distinct, processes. (However, we present the results of analyses using a composite lipid and a composite psychosocial-competency variable in the Supplemental Material available online.)

We then conducted secondary analyses to assess whether the obtained results were generalizable across families of different ethnic backgrounds and across both male and female children by adding interaction terms into the ordinal logistic regressions. Finally, we probed whether six possible alternative explanations might account for observed associations by rerunning the regressions with variables indexing (a) health conditions in the mothers prior to and during pregnancy, (b) mothers' prenatal depressive symptoms, (c) mothers' use of prenatal vitamins during pregnancy, (d) children's general physical health at 3 years, (e) children's BMI at approximately 5 years, and (f) whether children were placed in special education classes.

Results

Cord blood lipids and triglyceride as predictors of child psychosocial competency

Descriptive statistics for the sample included in the present study are presented in Table 1. As hypothesized, the primary analyses examining whether HDL, VLDL, or triglyceride levels in cord blood predicted children's psychosocial development 5 years later yielded consistent and significant associations across all blood markers and psychosocial outcomes. The estimated parameters for each cord blood marker are presented in Table 2 (parameter estimates for all covariates are presented in the Supplemental Material). These results indicate that higher HDL in cord blood at birth significantly predicts higher ratings of children's competence in emotion regulation, self-awareness, and interpersonal functioning at the end of their initial year of school. For example, a 1-standard-deviation increase in HDL is associated with 20% greater likelihood of children being rated in a higher category of interpersonal-functioning competency. In contrast, higher VLDL and triglycerides at birth significantly predict lower ratings of children's competence in each of the social and emotional domains. For instance, a 1-standard-deviation increase in VLDL is associated with a 13% lower likelihood of being rated in a higher category of emotion-regulation competency. Results examining composite variables of lipids and psychosocial competency were consistent with these findings and are presented in the Supplemental Material. Notably, these associations emerged over and above contributions of demographic and socioeconomic factors affecting children and were obtained after a 5-year period during which there are dramatic developmental and experiential changes in children's functioning.

Generalizability across ethnic backgrounds and children's sex

We conducted secondary analyses to test whether these associations were consistent across different ethnic groups and for both male and female children. Given

Table 1. Descriptive Statistics for Study Variables

Variable	Value
Sex (child)	
Male	51.6%
Female	48.4%
Ethnic background	
White British	37.9%
Pakistani British	51.1%
Other ethnic group	11.0%
History of hypertension (mother)	1.1%
History of diabetes (mother)	0.3%
Gestational diabetes (mother)	9.2%
Self-awareness competency (child)	
Below expectations	17.2%
At expectations	67.1%
Above expectations	15.7%
Emotion-regulation competency (child)	
Below expectations	17.2%
At expectations	68.7%
Above expectations	14.2%
Interpersonal-relationship competency (child)	
Below expectations	16.5%
At expectations	70.1%
Above expectations	13.4%
Special needs education (child)	17.9%
Age at baseline in years (mother)	M = 27.60, SD = 5.42, range = 15–44
Educational-attainment category (mother)	M = 2.40, SD = 1.10, range = 1–4
Income decile	M = 2.40, SD = 1.94, range = 1–10
High-density lipoprotein (child)	M = 0.65, SD = 0.22, range = 0.09–1.66
Very-low-density lipoprotein (child)	M = 0.24, SD = 0.12, range = 0.08–1.21
Triglycerides (child)	M = 0.54, SD = 0.27, range = 0.18–2.64
Depressive symptoms (mother)	M = 8.40, SD = 2.70, range = 7–28
Prenatal vitamin use (mother)	M = 0.60, SD = 1.60, range = 0–5
Body mass index (standardized relative to UK 1990 growth reference; child)	M = 0.22, SD = 1.09, range = −3.85 to 4.53
Overall physical health (child)	M = 2.37, SD = 0.84, range = 1–5

the unique ethnic composition of the BiB sample, it was possible to test whether associations between cholesterol and triglyceride markers and child psychosocial development were different for families from different ethnic backgrounds (White British, Pakistani British, and other) by including interaction terms between cord blood markers and ethnic-status dummy indicators in each model. These inclusions did not change the original pattern of associations and did not yield any significant interactive effects, indicating that associations between lipid markers and psychosocial development did not differ significantly across ethnic groups within the sample. Similarly, given sex differences in fetal environmental susceptibility (Sandman, Glynn, & Davis, 2013), we repeated similar analyses to test for moderation by children's sex. There were no significant interaction effects between children's sex and cord blood markers in predicting child functioning, again indicating that such links are robust for both male and female children.

Alternative explanations

Given the inherent limitations of correlational work, we tested whether findings could be accounted for by six possible alternative explanations: (a) health conditions in the mothers prior to and during pregnancy, (b) mothers' prenatal depressive symptoms, (c) mother's use of prenatal vitamins during pregnancy, (d) children's general physical health assessed at the age of 3 years, (e) children's BMI at approximately the time of the psychosocial-competency assessment, and (f) children's placement in special education classes.

Statistically adjusting for whether or not mothers had a history of hypertension, diabetes prior to pregnancy, and gestational diabetes coded from medical records

Table 2. Abbreviated Ordinal Logistic Regression Results for Models Predicting Social and Emotional Outcomes From Cholesterol and Triglyceride Levels

Model and predictor	Omnibus likelihood-ratio $\chi^2(8)$	*p*	Parameter estimate	*SE*	95% CI	Wald $\chi^2(1)$	*p*	Odds ratio (raw)	Odds ratio (standardized)
Self-awareness	91.79	< .001							
Cord blood HDL			0.65	0.26	[0.14, 1.16]	6.23	.013	1.92	1.16
Emotion regulation	131.50	< .001							
Cord blood HDL			0.73	0.26	[0.21, 1.25]	7.62	.006	2.08	1.18
Interpersonal relationships	115.62	< .001							
Cord blood HDL			0.82	0.27	[0.29, 1.34]	9.22	.002	2.26	1.20
Self-awareness	91.52	< .001							
Cord blood VLDL			–1.17	0.48	[–2.11, –0.24]	6.04	.014	0.31	0.87
Emotion regulation	129.43	< .001							
Cord blood VLDL			–1.13	0.48	[–2.07, –0.20]	5.62	.018	0.32	0.87
Interpersonal relationships	113.65	< .001							
Cord blood VLDL			–1.31	0.48	[–2.25, –0.37]	7.39	.007	0.27	0.86
Self-awareness	91.90	< .001							
Cord blood triglyceride			–0.55	0.22	[–0.98, –0.13]	6.42	.011	0.58	0.87
Emotion regulation	129.79	< .001							
Cord blood triglyceride			–0.53	0.22	[–0.96, –0.11]	5.99	.014	0.38	0.87
Interpersonal relationships	113.83	< .001							
Cord blood triglyceride			–0.60	0.22	[–1.03, –0.17]	7.57	.006	0.36	0.86

Note: Model results are presented using raw units for clinical interpretability. CI = confidence interval; HDL = high-density lipoprotein; VLDL = very-low-density lipoprotein.

did not change the pattern of results: Lipid markers remained significant predictors of children's psychosocial functioning for all markers and all outcomes. In addition, controlling for mothers' prenatal depressive symptoms did not change the associations between blood markers and functioning. These findings suggest that the observed effects were not due to more physically or psychiatrically symptomatic mothers having children who exhibit more problematic psychological functioning. Similarly, adjusting for mothers' use of prenatal vitamins during pregnancy also did not affect the independent significant contributions of each lipid marker, nor did it independently predict psychosocial competency, suggesting that such associations are likely not accounted for by micronutrient deficits. Although controlling for children's physical health rating at age 3 slightly reduced the significance of the association between HDL and self-awareness to a trend level, b = 0.74, SE = 0.41, 95% confidence interval (CI) = [−0.64, 1.54], p = .071, odds ratio (OR) = 2.10, all other associations between cord blood markers and child psychosocial development remained significant. The inclusion of children's standardized BMI relative to UK 1990 growth reference data (along with children's age in months at the time of BMI assessment) did not affect the pattern or significance of results.

Finally, adjusting for whether or not children were placed in special needs education also did not change the pattern of results, with the exceptions that the association between HDL and self-awareness was no longer significant, b = 0.40, SE = 0.27, 95% CI = [−0.14, 0.93], p = .144, OR = 1.49, and the association between HDL and emotion regulation was reduced to trend-level significance, b = 0.47, SE = 0.28, 95% CI= [−0.07, 1.02], p = .088, OR = 1.61. Thus, the observed associations between fetal lipids and subsequent psychosocial functioning do not appear broadly to be due to mothers' poor physical or psychological health during pregnancy, to micronutrient deficits in pregnancy, or to children's poor physical health, body mass, or neurodevelopmental disability.

Discussion

Drawing on an ethnically diverse birth cohort, we found that levels of HDL, VLDL, and triglycerides in umbilical cord blood prospectively predicted teachers' ratings of children's self-awareness, emotion-regulation, and interpersonal-relationship competencies at the age of 5 years. These findings were consistent across families of different ethnic backgrounds and for both male and female children. Furthermore, the possibilities that these associations were due to maternal psychological or physical health during pregnancy, use of prenatal vitamins, children's physical health at age 3 years, children's BMI, or special education status were not supported. Although we acknowledge that these results are correlational, they are nevertheless the first to document associations consistent with the formulation that fetal lipid levels may contribute to children's later psychological functioning.

Although we do not yet understand the precise mechanisms through which these associations emerge, multiple systems involved in psychological health are connected to lipid dynamics. For example, cholesterol and triglyceride levels are associated with immune and endocrine processes implicated in mood disorders (Pariante, 2017); specifically, non-HDL lipid accumulation is linked to greater proinflammatory signaling and increased glucocorticoid exposure (Fraser et al., 1999; Tall & Yvan-Charvet, 2015), whereas higher levels of HDL appear to buffer individuals from inflammation and to relate to more optimal T-cell ratios (Anantharamaiah et al., 2007; Maes et al., 1997). This may also inform neurobiological processes through crucial effects on the development of the brain and cognitive functioning (Yates, Sweat, Yau, Turchiano, & Convit, 2012). Likewise, cholesterol has been shown to play an important role in serotonin transportation, itself linked with inflammation (Scanlon, Williams, & Schloss, 2001). Low HDL may lead to low levels of serotonin in the central nervous system and insufficient regulation of limbic structures in the brain, including the amygdala (Eriksen et al., 2017; Siever, 2008).

That levels of HDL, VLDL, and triglycerides at birth were significantly related to psychosocial functioning 5 years later attests to the enduring effects of the fetal period on psychological health and suggests that lipid levels may be novel mechanisms that should be considered in the context of children's psychological functioning. While further work using experimental methodology will be critical to interrogating causal links, this documented association has several exciting implications. For example, because lipid levels are easily assessed in peripheral blood and routinely processed at hospitals, should additional research confirm predictive associations, it would be possible to use lipids to support assessments of risk without requiring more invasive, expensive, or specialized testing. Furthermore, lipid levels are readily modifiable through behavioral interventions. Therapies (such as dietary changes or exercise programs) that support higher levels of HDL and lower levels of LDL in pregnant or nursing mothers might be used to help prevent or reduce risk for children. In addition, the possibility of mechanistic links has important implications for policy research. Current efforts to provide pregnant women and young children with access to high-nutrition food through grocery subsidization programs are clearly important for physical growth and health; the current study suggests that such programs might also improve psychological outcomes for children, further justifying the programs' economic costs.

Despite these implications, it is important to acknowledge several limitations. First, although the temporal sequence of assessments makes a reverse-directionality model unlikely, it is nevertheless possible that confounder variables accounted for observed associations. For example, women who have more resources may be able to engage in healthier behaviors during pregnancy and may also provide children with higher quality postnatal environments. It is worth noting that the present findings held even after we accounted for a socioeconomic status indicator (i.e., maternal education); of course, it is possible that other forms of resources, such as social support, or other variables, such as genetics, affect both lipid levels and later child psychological health. Second, we were unable to test directly several factors that may contribute to associations, including family behaviors or characteristics such as maternal BMI or exercise during pregnancy, diet during pregnancy and childhood, or maternal personality factors. We were also unable to examine several possible biological mechanisms through which fetal lipids may affect later psychosocial functioning, such as markers of inflammation, neurotransmitter activity, or cortisol production. Testing the contribution of these variables will be crucial for future work. Here, research using experimental or quasiexperimental designs in humans and animals will be critical to advancing scientific knowledge. Third, although associations were statistically significant, effect sizes were small. However, as Durlak (2009) argues, small effect sizes may still be practically meaningful if the outcome is important, such as, in our opinion, failing to achieve expected psychosocial milestones by the end of the first school year. For comparison, the observed effects were comparable in size with those found between experiences of stressful events or smoking during pregnancy and child behavior problems at age 2 years (Robinson et al., 2008). Regardless, however, it is clear that many factors contribute to children's emotional and social functioning beyond lipid levels at birth.

Despite these limitations and unanswered questions, the current study has several important strengths. First, it drew on a large, ethnically diverse prospective birth cohort, permitting generalizations regarding child development that extend beyond White families or families of European descent. Second, the current study utilized a range of assessment sources, including biological samples, medical chart reviews, parent reports, and teacher ratings. Notably, the primary analyses avoided self- or parent reports, reducing the possibility of method or reporter bias. Third, it examined lipid profiles in umbilical cord blood, providing information on the fetus at the earliest feasible assessment point and offering a strong directional test of associations. Taken together, the current results indicate that levels of cholesterol and triglycerides at birth are significantly related to children's psychological and social functioning 5 years later, suggesting that fetal exposure to lipids may represent a novel form of biological embedding for psychological health risk.

Action Editor

June Gruber served as action editor for this article.

Author Contributions

E. M. Manczak developed the study concept with input from I. H. Gotlib. E. M. Manczak conducted the analyses and drafted the manuscript. I. H. Gotlib provided critical revisions. Both authors approved the final version of the manuscript for submission.

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Declaration of Conflicting Interests

The author(s) declared that there were no conflicts of interest with respect to the authorship or the publication of this article.

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Supplemental Material

Additional supporting information can be found at http://journals.sagepub.com/doi/suppl/10.1177/0956797619885649

Open Practices

Researchers can obtain the data used in the present study through the Born in Bradford study, as outlined at https://borninbradford.nhs.uk/research/how-to-access-data/. The design and analysis plans for the current study were not preregistered.

Note

1. Reception year in the United Kingdom is equivalent to kindergarten in the United States.

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