

The Long-Term Effects of Breastfeeding on Child and Adolescent Mental Health: A Pregnancy Cohort Study Followed for 14 Years

Wendy H. Oddy, PhD, Garth E. Kendall, PhD, Jianghong Li, PhD, Peter Jacoby, MSc, Monique Robinson, BA (Hons) Psych, Nicholas H. de Klerk, PhD, Sven R. Silburn, MSc, Stephen R. Zubrick, PhD, Louis I. Landau, MD, and Fiona J. Stanley, MD

Objectives To determine whether there was an independent effect of breastfeeding on child and adolescent mental health.

Study design The Western Australian Pregnancy Cohort (Raine) Study recruited 2900 pregnant women and followed the live births for 14 years. Mental health status was assessed by the Child Behaviour Checklist (CBCL) at 2, 6, 8, 10, and 14 years. Maternal pregnancy, postnatal, and infant factors were tested in multivariable random effects models and generalized estimating equations to examine the effects of breastfeeding duration on mental health morbidity.

Results Breastfeeding for less than 6 months compared with 6 months or longer was an independent predictor of mental health problems through childhood and into adolescence. This relationship was supported by the random effects models (increase in total CBCL score: 1.45; 95% confidence interval 0.59, 2.30) and generalized estimating equation models (odds ratio for CBCL morbidity: 1.33; 95% confidence interval 1.09, 1.62) showing increased behavioral problems with shorter breastfeeding duration.

Conclusion A shorter duration of breastfeeding may be a predictor of adverse mental health outcomes throughout the developmental trajectory of childhood and early adolescence. (*J Pediatr* 2010;156:568-74).

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Neurobehavioral development is an essential aspect of childhood development and an estimated 1 in 5 children have some mental health problem in Australia.¹ Between 10% to 20% of children globally have emotional or behavioral problems, which have been listed as 1 of the 6 priority areas for future strategic directions for improving the health and development of children and adolescents.² Although family, social, economic, and psychological disadvantages associated with poverty, low parental income and education, single-parenthood, and living in deprived areas are key risk factors for child mental health problems,³ little is understood about the potential impact of early infant feeding on subsequent mental health.

Compelling evidence exists for a relationship between breastfeeding, developmental milestones,⁴ and cognition⁵ from longitudinal,⁶ experimental,⁷ and neurodevelopmental studies.⁸ However, to date there has been conflicting evidence with regard to the psychological and behavioral outcomes associated with breastfeeding, potentially caused by inherent methodologic challenges, including inadequate adjustment for confounding factors and problems with study design.^{9,10}

The aim of this study was to overcome some of the main methodologic challenges that have limited previous research and in so doing determine whether an independent effect of breastfeeding on child and adolescent mental health was apparent with data collected from a large prospective pregnancy cohort study monitored to 14 years of age.

Methods

From 1989 to 1992, 2900 women were enrolled in the Western Australian Pregnancy Cohort (Raine) Study through the public antenatal clinic at the major obstetric hospital in Perth, Western Australia, and nearby private practices. The criteria for enrollment were gestational age between 16 and 20 weeks, sufficient proficiency in English to understand the implications of participation, an expectation to deliver at the hospital, and an intention to remain in Western Australia for long-term follow-up.¹¹

Comprehensive data on family, social, economic, and demographic factors, and medical and obstetric history were obtained from each parent at enrollment

From the Telethon Institute for Child Health Research, Centre for Child Health Research (W.O., G.K., J.L., P.J., M.R., N.K., F.S.) and the Faculty of Medicine and Dentistry (L.L.), The University of Western Australia, the School of Nursing and Midwifery (G.K.), Centre for International Health & School of Public Health (J.L.), and the Centre for Developmental Health (S.S., S.Z.), Curtin University of Technology, Perth, Australia

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CBCL	Child Behaviour Checklist
EE	Estimate of effects
POBW	Proportion of optimal birth weight

(average recruitment age: 18 weeks gestation) and updated during the 34th week. The women delivered at the obstetric hospital, and the babies were examined at 2 days by a pediatrician or midwife. Both singleton and twin pregnancies and 2868 live births were included in the study. Follow-up surveys at around ages 1, 2, 3, 5, 8, 10, and 14 involved questionnaire completion by caregivers, a structured interview, and clinical examination of all available children. For all follow-ups the response rate on the basis of the initial cohort was above 75% except the 2- (70%, because of being a partial follow-up), 10- (70%), and 14-year (65%) follow-ups.

Questionnaires regarding general health and well-being of the family and the child were posted by mail before the structured interviews and clinical assessments at each follow-up. Caregivers were asked to bring the completed questionnaire to the interview and examination with the child health nurse, who checked the questionnaire for completeness, examined the child, conducted developmental assessments, and interviewed the parents at each clinic assessment.

A variety of reliable and well-validated measures were implemented to capture information regarding the critical developmental stages of the children. In this study we have focused on the parent-report Child Behaviour Checklist (CBCL/4-18)¹² as the outcome variable at the 5-, 8-, 10-, and 14-year follow-ups. The CBCL/2-3, validated for use with 2-year-old children, was applied at the 2-year follow-up and included appropriate sleep questions and other subtle differences for this age group.¹³

The CBCL/4-18 is a 118-item instrument that assesses behavioral psychopathology in children according to 8 syndrome constructs that include withdrawn; anxious/depressed; somatic complaints; social problems; attention problems; thought problems; delinquent behavior; and aggressive behavior. The syndrome scales of withdrawn, anxious/depressed, and somatic complaints are grouped and scored as internalizing problems, and the syndrome scores of delinquent behavior and aggressive behavior are grouped and scored as externalizing problems. A total score of overall mental health morbidity, representing the sum of all the items, is derived for the entire scale. Each of the syndrome scales and summary scales are converted to age-sex-appropriate normalized T-scores, with a mean of 50 and standard deviation of 10 points. Higher scores represent more disturbed behavior. In accordance with the normative criteria, we applied the recommended clinical cut-off scores ($T \geq 60$) to total, internalizing, and externalizing T-scores to distinguish those children with a "mental health problem" of clinical significance.¹² Therefore we were able to analyze mental health outcomes at all years with both the continuous CBCL T-score and a binary variable reflecting clinical significance.

Duration of breastfeeding

Breastfeeding duration was defined as the age at which breastfeeding was stopped in months, but it did not preclude the intake of solid foods. In preliminary analyses, duration of breastfeeding was considered as a continuous variable in months, and linear and nonlinear effects were examined.

The results changed little when a simple binary variable was used with duration of any breastfeeding dichotomized as less than 6 months (including never breastfed) compared with 6 months or more. Approximately half the cohort was in each group (52% breastfed for 6 months or more compared with 48% breastfed for less than 6 months). A proxy measure of exclusive breastfeeding (defined as the age in months that milk other than breast milk was introduced) was investigated in initial analyses, but use of this variable did not change the substantive conclusions drawn from the findings on the basis of any breastfeeding. Although the mothers in our cohort were not breastfeeding "exclusively" at 6 months by the World Health Organization definition of exclusive breastfeeding,¹⁴ they were continuing to breastfeed past 6 months with the addition of solid food.

Potential confounders

Potential confounders were: maternal age at child's birth (grouped as <20 years, 20 to 24 years, 25 to 29 years, 30 to 34 years, and 35 or more years), and maternal education (grouped as 12 years or less compared with >12 years). We also adjusted for maternal smoking (yes: no); family income (<\$23 000 compared with greater than this), family structure (whether the biological father lived with the family) and life stress events (3 or more stressful events versus 2 or fewer events). Maternal postnatal depression, diagnosed by a doctor, was measured retrospectively at the 10-year follow-up. The birth data included in the model were child sex and the proportion of optimal birth weight.¹⁵ We investigated whether there was a nonlinear relationship between proportion of optimal birth weight (POBW) and our outcome variable by including POBW in the model as a squared term. This did not increase the fit of our model, and therefore the inclusion of POBW as a continuous variable was appropriate.¹⁵

Statistical analysis

The χ^2 tests for trends were conducted with standard bivariate models between the primary exposure and the outcomes. To look at the estimated effect of breastfeeding on child mental health over time, we constructed regression models with CBCL as both a continuous outcome (T-scores), which allowed analysis of the change in scores, and a binary outcome (clinical cut-off for morbidity $T \geq 60$), which provided information on the clinical relevance of such score fluctuations. Factors identified as being significantly associated with child mental health were adjusted as potential confounders (maternal age, education, smoking in pregnancy, stress in pregnancy, POBW, family income, and family structure).³ A loss of independence because of repeated observations on the same individuals was accounted for by incorporating a random intercept at the subject level in linear models for the continuous CBCL outcome, and by use of generalized estimating equations in logistic models for the binary outcome. Regression coefficients for the linear models, odds ratios for the logistic models, confidence intervals and *P* values are reported. All analyses were undertaken with SPSS-PC+

software (Version 15; SPSS, Inc., Chicago, Illinois). Statistical significance was defined at the customary 2-sided $P = .05$ level.

The ethics committees of King Edward Memorial Hospital and Princess Margaret Hospital for Children approved the protocol for the study. The parent or guardian of each child provided written consent for the child's participation.

Results

There were missing cases at each follow-up because of the longitudinal nature of the data collection, and these were excluded from analysis. Of the 2366 participants with available data, 11% were never breastfed, 19% were breastfed for less than 3 months, 19% were breastfed for between 3 and up to 6 months, 28% were breastfed between 6 and up to 12 months, and 24% were breastfed for 12 months or more. The children who were breastfed for 6 months or longer had significantly lower mean CBCL scores across total, internalizing, and externalizing domains (Table I). Younger mothers, those with 12 years education or less, those who were stressed, with low incomes, or who smoked during pregnancy were more likely to breastfeed for less than 6 months. Postnatal depression and inappropriate fetal growth were also associated with a shorter duration of breastfeeding. There were significant downward trends in the proportions of children above the CBCL cut-off score at all ages as duration of breastfeeding increased (Table II). These trends were most pronounced in the total and externalizing domains.

Shorter breastfeeding duration (<6 months compared with ≥ 6 months) was associated with a higher mental health score (representing poorer behavior) across each of the internalizing (of effect estimation [EE] 0.92; 95% confidence interval [CI]: 0.15, 1.68), externalizing (EE 1.33; 95% CI: 0.51, 2.15) and total problem (EE: 1.45; 95% CI: 0.59, 2.30) domains (Table III). The effect was weaker for internalizing problems compared with total and externalizing problem scores. The same analysis with the continuous breastfeeding variable (in months), showed that breastfeeding duration per month was inversely associated with CBCL total (EE: -0.08; 95% CI: -0.14, -0.02), internalizing (EE: -0.06; 95% CI: -0.12, -0.01) and externalizing (EE: -0.08; 95% CI: -0.14, -0.02) scores (data not shown), representing improved behavior with each additional month of breastfeeding. Analyses with binary mental health outcomes revealed similar trends, with a shorter duration of breastfeeding being consistently associated with increased risks for mental health problems of clinical significance through childhood and into adolescence (Table IV). Prenatal risk factors such as smoking, experience of multiple stress events, low family income, younger maternal age, and the absence of the biologic father in the family home, plus postnatal depression, were also associated with increasing CBCL scores and in some cases mental health morbidity (Tables III and Tables IV), as has been previously identified.³

Table I. Characteristics of the cohort

Outcome and exposure variables	Breastfeeding <6 months	Breastfeeding ≥ 6 months	Difference in Mean P^*
Total T-score (Mean [SD])			
Age 2	48.12 (10.60)	46.29 (9.97)	
Age 5	53.06 (10.43)	50.73 (10.00)	
Age 8	51.73 (11.31)	48.74 (10.68)	
Age 10	48.77 (11.50)	46.48 (10.99)	
Age 14	48.23 (11.57)	45.17 (11.47)	
Internalizing T-score (Mean [SD])			
Age 2	47.91 (9.52)	46.53 (9.44)	
Age 5	51.09 (10.20)	49.65 (9.86)	
Age 8	51.62 (10.61)	49.84 (10.28)	
Age 10	50.00 (1.063)	48.85 (10.40)	.02
Age 14	47.60 (10.80)	45.88 (10.74)	
Externalizing T-score (Mean [SD])			
Age 2	49.60 (10.30)	47.56 (9.82)	
Age 5	53.26 (10.22)	50.78 (9.93)	
Age 8	51.59 (11.03)	48.46 (10.10)	
Age 10	48.69 (10.78)	46.20 (10.34)	
Age 14	49.74 (10.98)	46.62 (10.74)	
Maternal factors at enrollment into study (% [n/N]) [†]			
Maternal age			
<20 years	12.6 (142/1127)	3.2 (40/1236)	
20-24	27.2 (306/1127)	14.1 (174/1236)	
25-29	29.9 (337/1127)	32.4 (400/1236)	
30-34	21.5 (242/1127)	32.0 (395/1236)	
35+	8.9 (100/1127)	18.4 (227/1236)	
Maternal education			
Less than or equal to year 12	74.3 (839/1129)	53.0 (658/1236)	
Biological father living with family			
No	13.2 (149/1130)	9.4 (116/1238)	
Maternal factors in pregnancy			
Smoking			
Yes, any	47.8 (496/1037)	28.2 (330/1172)	
Low family income (<\$23 000 per annum)			
Yes	33.5 (352/1052)	25.0 (297/1190)	
Life stress events			
3 or more upsets	15.0 (169/1130)	12.2 (151/1238)	.03
Factors after infant birth			
Proportion of optimal birth weight (<85%)	20.1 (227/1127)	15.6 (193/1238)	
Infant sex (male)	50.8 (572/1127)	51.2 (634/1238)	.428
Postnatal depression			
Yes, diagnosed by a doctor	9.3 (80/858)	7.3 (76/1036)	

*All values significant at $P < .005$ unless otherwise stated.

[†]Missing cases excluded from analysis.

Discussion

We have shown that a shorter duration of breastfeeding was associated with increased mental health morbidity throughout a period spanning early childhood to adolescence. This association was evident for the continuous measures of total, externalizing, and internalizing behaviors, as well as for dichotomous measures of morbidity, which reflect clinically significant behavioral problems. Furthermore, these

Table II. Percentage of children in mental health morbidity groups (total, internalizing and externalizing) and breastfeeding duration (never, <3 mo, 3 mo- <6 mo, 6 mo, <12 mo, 12+ mo)

Breastfeeding duration	Age 2 (n = 1899)	Age 5 (n = 2036)	Age 8 (n = 1938)	Age 10 (n = 1895)	Age 14 (n = 1695)
Total morbidity					
Never breastfed	16.1	26.3	19.4	15.2	16.7
<3 mo	16.4	31.2	29.8	20.9	18.9
3 mo-<6 mo	9.6	20.6	20.3	16.4	12.6
6 mo-<12 mo	9.3	18.4	16.2	12.1	12.6
12+ mo	9.6	16.0	13.5	12.6	10.9
Test for trend*	.001	<.001	<.001	.004	.004
Internalizing morbidity					
Never breastfed	12.8	21.6	18.9	18.2	19.4
<3 mo	11.3	21.8	25.6	21.2	16.4
3 mo-<6 mo	5.6	17.6	20.6	19.9	11.3
6 mo-<12 mo	7.3	16.7	15.8	15.1	12.2
12+ mo	7.2	16.0	18.0	15.8	9.3
Test for trend*	.007	.013	.022	.037	<.001
Externalizing morbidity					
Never breastfed	16.7	21.1	20.0	13.3	20.8
<3 mo	21.2	30.9	25.6	18.4	20.4
3 mo-<6 mo	10.5	18.4	18.6	13.2	14.6
6 mo-<12 mo	12.1	17.9	16.0	10.4	13.2
12+ mo	9.8	16.4	12.2	9.4	12.3
Test for trend*	<.001	<.001	<.001	.001	.001

Mo, Month.

*P value for linear by linear association.

associations persisted after adjustment for family, social, economic, birth, and psychological factors in early life.

The effect of feeding type on infant health and development was first discussed more than half a century ago when breastfed infants were reported to have better cognitive outcomes in childhood than artificially fed infants.¹⁶ In relation to intelligence, the breastfed infant has been shown to have an advantage over the non-breastfed infant,¹⁷ although some studies have been criticized for neglecting the possible genetic influence of maternal intelligence.¹⁰ Despite the evidence for an impact of breastfeeding on cognitive development, there have been few published articles on mental health outcomes since the early theorists working within a developmental psychopathological framework,¹⁶ which is surprising given the popularity of attachment theory in relation to healthy psychological development.¹⁸

Existing research tends to focus on infant and early childhood behavior,¹⁹ and, consistent with our findings, infants who are breastfed for at least 6 months have a distinct developmental advantage over non-breastfed infants and infants breastfed for a short period of time.²⁰ One study found that low-birth-weight infants fed breast milk had significantly higher scores for engagement and emotional regulation on the Bayley Developmental Scale than infants not given breast milk,²¹ although this study did not differentiate the effects of feeding at the breast versus feeding of breast milk through a tube or bottle.²² Another study found that breastfed infants were more able to face adverse stimuli with greater degrees of control, show more appropriate amounts of change in arousal levels, and were more able to return to moderate states of arousal than formula-fed infants.²³ However, much of this research is based on small

Table III. Association between breastfeeding duration and mental health as a continuous outcome

Exposure variables	Random effects model - years 2 to 14 inclusive*		
	Total mental health score	Internalizing score	Externalizing score
Breastfeeding duration (< 6 months: 6+ months)			
EE	1.45	0.92	1.33
95% CI	0.59, 2.30	0.15, 1.68	0.51, 2.15
Significance (P value)	.001	.019	.001
Maternal age in years			
EE	-0.14	-0.09	-0.16
95% CI	-0.22, -0.06	-0.16, -0.02	-0.24, -0.09
Significance (P value)	.001	.015	<.001
Low family income in pregnancy (Yes: No)			
EE	1.37	0.92	1.63
95% CI	0.39, 2.35	0.05, 1.80	0.69, 2.56
Significance (P value)	.006	.038	.001

EE, Effect estimation.

*Adjusted for all factors in the model. Also adjusted for proportion of optimal birth weight and child gender, and indicates the predicted mean difference in CBCL score between levels of the predictor variable.

Table IV. Association between breastfeeding duration and mental health morbidity of clinical significance

Exposure variables	Multivariable generalized estimating equation model- years 2 to 14 inclusive		
	Total morbidity	Internalizing morbidity	Externalizing morbidity
Breastfeeding duration (<6 months: 6+ months)			
OR	1.33	1.21	1.23
95% CI	1.09, 1.62	1.00, 1.46	1.01, 1.49
Significance (<i>P</i> value)	.005	.054	.044
Maternal age in years			
OR	0.98	0.98	0.98
95% CI	0.96, 1.00	0.97, 1.00	0.96, 1.00
Significance (<i>P</i> value)	.034	.074	.024
Maternal education (Year 12 or less: >year 12)			
OR	1.05	1.14	1.19
95% CI	0.85, 1.30	0.93, 1.38	0.96, 1.47
Significance (<i>P</i> value)	.643	.201	.112
Biological father living with family in pregnancy (No: Yes)			
OR	1.32	1.18	1.37
95% CI	0.96, 1.82	0.86, 1.62	1.00, 1.87
Significance (<i>P</i> value)	.089	.296	.048
Smoking in pregnancy (Yes: No)			
OR	1.33	1.26	1.34
95% CI	1.08, 1.64	1.02, 1.55	1.09, 1.65
Significance (<i>P</i> value)	.008	.029	.006
Low family income in pregnancy (Yes: No)			
OR	1.43	1.17	1.54
95% CI	1.14, 1.78	0.94, 1.45	1.24, 1.91
Significance (<i>P</i> value)	.002	.162	<.001
Life stress events in pregnancy (3 or more upsets : less than 3 upsets)			
OR	2.02	1.89	1.83
95% CI	1.57, 2.58	1.49, 2.40	1.42, 2.36
Significance (<i>P</i> value)	<.001	<.001	<.001
Postnatal depression (Yes: No)			
OR	1.69	1.43	1.63
95% CI	1.25, 2.28	1.06, 1.93	1.19, 2.22
Significance (<i>P</i> value)	.001	.018	.002

OR, Odds ratio.

Adjusted for all factors in the model. Also adjusted for proportion of optimal birth weight and child sex.

and nonrandom samples, with a few exceptions.⁴ One exception includes the results from a large, cluster-randomized trial, whereby the authors did not find significant differences in behavioral outcomes at age 6 for those infants whose mothers were encouraged to breastfeed exclusively and for longer durations; however, the age at follow-up was considerably less than in our study, the children were only assessed at 1 point in time and a short-form behavioral measure was used.⁹ Later childhood outcomes in breastfed children include greater resilience against stress and anxiety associated with parental separation and divorce at 10 years in a study of 8958 children,²⁴ but this study was based on long-term retrospective data and thus prone to recall bias.

Our longitudinal pregnancy cohort study allowed examination over time and is the major strength of the study. We achieved excellent response fractions from a large prospectively-recruited sample. We were able to assess the emergence of mental health problems in relation to a wide variety of social, biologic, and demographic factors that the child was exposed to in utero and early life, thus producing a high level of evidence of persistent associations between breastfeeding and mental health problems in children and

adolescents.²⁵ A further strength of the study was the analysis of multiple domains of mental health problems as both continuous and threshold (dichotomous) outcomes. A limitation of our study was a lack of biochemical data on breast milk composition because breast milk samples were not collected.

There are several possible mechanisms that may explain the association between breastfeeding and child mental health. Stimulation associated with maternal contact during breastfeeding may have a positive effect on the development of neuroendocrine aspects of the stress response, which may affect later child development.²⁶ Although there is no such evidence to date in human studies, this hypothesis is informed by rat models. Rat pups who experienced a greater frequency of maternal contact during nursing in the first 10 days after birth (licking and grooming) exhibited a more controlled response to acute stress as adults (eg, a lower magnitude of hypothalamic-pituitary-adrenal response).²⁷ In human beings the pattern of mother-infant interaction differs between breastfeeding and bottle feeding. The amount of mutual touch, tactile stimulation, and mother's gaze to infant were significantly elevated during

breastfeeding compared with bottle-feeding.²⁸ Breastfeeding may also be an indicator of a secure attachment status, which is known to have a positive influence on the child's psychological development into adulthood.²⁹

Breastfeeding may have long-term consequences for child mental health outcomes because maternal milk is a rich source of fatty acids and other bioactive components essential for development.³⁰ Furthermore, breast milk may contain elements relevant to the stress response. For example, the hormone leptin in breast milk may reduce stress in infants through its action on the hippocampus, hypothalamus, pituitary gland, and adrenal gland,²⁴ whereas formula milk may have a depressant effect on newborn behavior.³¹

There is a possibility that the observed associations in our study do not indicate a causal effect of a lack of breastfeeding on subsequent mental health but may be due to difficult babies breastfeeding for less duration and subsequently progressing to poorer mental health. Difficult infant temperament has been associated with reduced breastfeeding.³² Although not entirely predictive of later mental health status, there is evidence to suggest that the trajectory for poor mental health is influenced by infant temperament.³³ Data on the difference in mother/infant interaction between breastfeeding and non-breastfeeding mothers should be collected in future studies. Maternal factors in pregnancy and postnatal depression measured retrospectively when the children were 10 years of age continued to show significant associations with later adolescent mental health in our analysis. The knowledge of the underlying mechanism between breastfeeding and later child mental health would enable a more effective dissemination of the breastfeeding message for optimal development.

It has been proposed that breastfeeding is a marker of other unmeasured maternal characteristics.¹⁰ For example, mothers who breastfeed their infants may have personal and family characteristics that directly influence the child's stress-response or anxiety after divorce.²⁴ Similarly, breastfeeding mothers may have exposure to superior prenatal conditions because women who breastfeed are also more likely to engage in health-enhancing behavior. Our analysis has adjusted or tested for a variety of these characteristics, such as life stress events during pregnancy, smoking in pregnancy, and postnatal depression as diagnosed by a doctor. Although in our study we did not have data assessing maternal intelligence directly, we were able to use maternal education level as a proxy for maternal cognitive capacity.¹⁰ Following multivariable adjustment, shorter breastfeeding duration remained a significant predictor of poorer mental health throughout early and mid childhood and into adolescence in all models.

There is reluctance in previous research to suggest an association between breastfeeding and later mental health partly because of the possibility of alternative explanations such as parenting behaviors and parental cognitive ability³⁴ and partly because of the concern for creating guilt in women who do not breastfeed. In developed nations breastfeeding is more likely to be practiced in communities with greater

economic and social resources,^{17,21} and the associated confounding socioeconomic effects complicate the interpretation of this association.³⁵ Our study modeled and adjusted for many of these underlying factors; however, we acknowledge that not all of the potential confounders were measured and adjusted for and that the confounding variables that we have controlled for may not have been measured with sufficient validity and precision.

Breastfeeding for a longer duration appears to have significant benefits for the onward mental health of the child into adolescence. Following adjustment of the associated socioeconomic, psychological and birth exposures in early life, breastfeeding for 6 months or longer was positively associated with the mental health and well-being of children and adolescents. Therefore interventions aimed at increasing breastfeeding duration could be of long-term benefit for child and adolescent mental health. ■

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Reprint requests: W.H. Oddy, PhD, Telethon Institute for Child Health Research, PO Box 855, West Perth, WA, 6872, Australia. E-mail: wendyo@icmr.uwa.edu.au.

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