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ORIGINAL ARTICLE

The parental bonds of adolescent girls and next-generation maternal–infant bonding: findings from the Victorian Intergenerational Health Cohort Study

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Abstract The purpose of this study was to examine the extent to which adolescent bonding problems with parents predict next-generation maternal–infant bonding problems at 2 and 12 months postpartum. Data were from a two-generation prospective cohort study of 1026 offspring (3 perinatal waves) born to participants of a two-decade (10-wave) study of 1943 adolescents. Dyads in this analysis were 395 mothers (29–36 years) of 606 offspring (305 female). At 16 years, we assessed adolescents' perceptions of their mother's and father's care and control, separately and in combination. Subsequently, when participants were adult mothers of infants 2 and 12 months postpartum, we assessed impaired maternal–infant bonding, infant-directed rejection-anger, and caregiving anxiety. Adolescent–parent bonding problems were strongly predictive of women's subsequent bonding problems with infants. In particular, impaired postpartum maternal bonding was predicted by adolescent reports of low paternal care (12 months: OR=3.1, 95% CI 1.1–8.6) and high maternal control (12 months: OR=3.7, 95% CI 1.4–9.7). In combination, high maternal control and low paternal control also predicted impaired postpartum bonding (2 months: OR=5.0, 95% CI 1.3–20; 12 months: OR=12, 2.6–56), caregiving anxiety (2 months: OR=4, 95% CI 1.5–11; 12 months: OR=8.8, 95% CI 1.8–43), and rejection/anger (12 months: OR=4.1, 95% CI 1.0–16). Further combinations of care and overprotection that significantly predicted postpartum bonding problems are presented. Our results indicate that adolescent girls who experience high maternal control and low paternal care are at higher risk for subsequent maternal-infant bonding problems. The strength of associations suggests that interventions should begin well before pregnancy.

Keywords Maternal bond · Mother–infant relationship · Postpartum bond · Parental bond · Adolescence

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Maternal postpartum bonding problems may extend from caregiving anxiety to infant aversion, anger or hatred, escalating at times to abuse (Brockington 2004). They are present in an estimated 10–25% of women referred to psychiatrists after childbirth (Brockington 2004). Community prevalence is yet to be established (Brockington 2011). Bonding problems have a profound effect on offspring mental health (Brockington 2011). Most research has focused on the contribution of perinatal depression to maternal–infant bonding problems (Maas et al. 2012; Righetti-Veltema et al. 2002); yet, depressive symptoms, in combination with other perinatal factors, account for only about a third of the variance in maternal-bonding quality (low to high) (Damato 2004; Rossen et al. 2016). One explanation is that family history plays a role. A

mother's prior bonding problems with her own attachment figures pose a potential risk for subsequent bonding problems with her own offspring, thereby creating a conduit for mental health risk (George and Solomon 2008). However, evidence on cross-generation transmission is notably limited by reliance on retrospective recall of parent–child bonding history (Choi et al. 2010; van Bussel et al. 2010).

Here we report findings from a 20-year Australian prospective intergenerational cohort in which respondents are parents who provided initial data in adolescence and were then followed into their late twenties and across the first year of offspring life. In mid-adolescence (16 years), participants reported on their bonds with their mothers and fathers. This important period in the life course marks a key transition from being a receiver of care in preparation to provision of parental care (Arnett 2000). During this time, internal working models of caregiving develop in preparation for future offspring (George and Solomon 2008).

The purpose of this study was to examine the extent to which women who experienced problems bonding to their infant/s, at 2 and/or 12 months postpartum, had previously reported problems bonding with their mothers and fathers, separately and combined, during their own adolescence.

Methods

Participants and procedure

Our data were from 395 mothers (mean (SD) age at childbirth, 32.3 (1.8) years) of 606 children (305 female) who were participants in the Victorian Adolescent Health Cohort Study (VIHCS), a prospective intergenerational offshoot of the Victorian Adolescent Health Cohort Study (VAHCS). VAHCS participants were recruited as a representative sample of secondary school students in 1992 and followed across 10 waves. Recruitment was in two stages with 45 schools selected from a stratified frame of Government, Catholic and Independent secondary schools. One school was unavailable for the follow-up study, leaving 44 schools. In stage 2, we randomly selected students, typically aged 14–15 years, from a single intact year 9 class from each school for participation in wave 1. At wave 2 (6 months later), when the students were in year 10, a second intact class from each school was selected at random. The methodology has been described previously (Patton et al. 2014).

In waves 1 to 6 (1992–1995), participants responded at 6-month intervals to branched questionnaires administered on laptop computers at school. Of the total eligible sample of 2032 students, 1943 (1000 female) participated in at least one adolescent wave. Waves 7 to 9 were conducted post-secondary school in 1998, 2002 and 2006 when participant mean ages were respectively 20.6, 24 and 29 years. At each wave, a range of mental health and behavioural outcomes were assessed, including common mental disorders, substance misuse, personality disorder, self-harm and sexual risk behaviours.

Between 2006 and 2013, we contacted active VAHCS participants every 6 months by email, telephone or post to identify those who were pregnant or with a child under 1 year. The mother of the child (either a VAHCS participant or partner) was invited to complete a telephone interview during the third trimester of pregnancy, and again at 10 weeks and 1 year postpartum, for each infant born during the recruitment period. At each wave, assessments included parent and offspring mood and behaviour, parental mental health, substance use, relationship quality, caregiving behaviours and offspring temperament. Figure 1 presents a visual chart of data collection.

In the analysis reported here, we used data from female VAHCS participants who completed at least one of the two VIHCS postpartum interviews. Approval was granted for VAHCS and VIHCS study protocols by the Royal Children's Hospital Ethics in Human Research Committee (Melbourne, Australia).

Measures

Preconception exposure

We used the Parental Bonding Instrument (PBI; Parker et al. 1979) at mean (SD) age 16.8 (0.41) years (wave 5) to assess adolescents' perceived quality of the bond with their mothers and fathers. We asked participants to describe their relationship with each parent over the time they were growing up until the time of interview. Those not living with both biological parents were requested to describe the relationship with their main maternal and paternal figure over the previous 5 years. PBI reliability and validity is well established; it is resistant to mood states and life events and has long-term stability up to 20 years (Murphy et al. 2010). The 25-item measure comprises two subscales per parent of *care* and *control* (Parker et al. 1979). Responses are made on a 0–3 scale ranging from 0 = 'very unlike my parent' to 3 = 'very like my parent'.

The 12 *care* items reflect offspring perceptions of parenting that range from cold, neglectful and indifferent to affectionate, warm and empathic (e.g. 'my father/mother seemed emotionally cold to me' and 'my father/mother appeared to understand my problems and worries'). The 13 *control* items range from parental support of independence and autonomy to controlling behaviours and overprotection (e.g. 'my father/mother let me decide things for myself' and 'my father/mother tried to make me feel dependent on him/her').

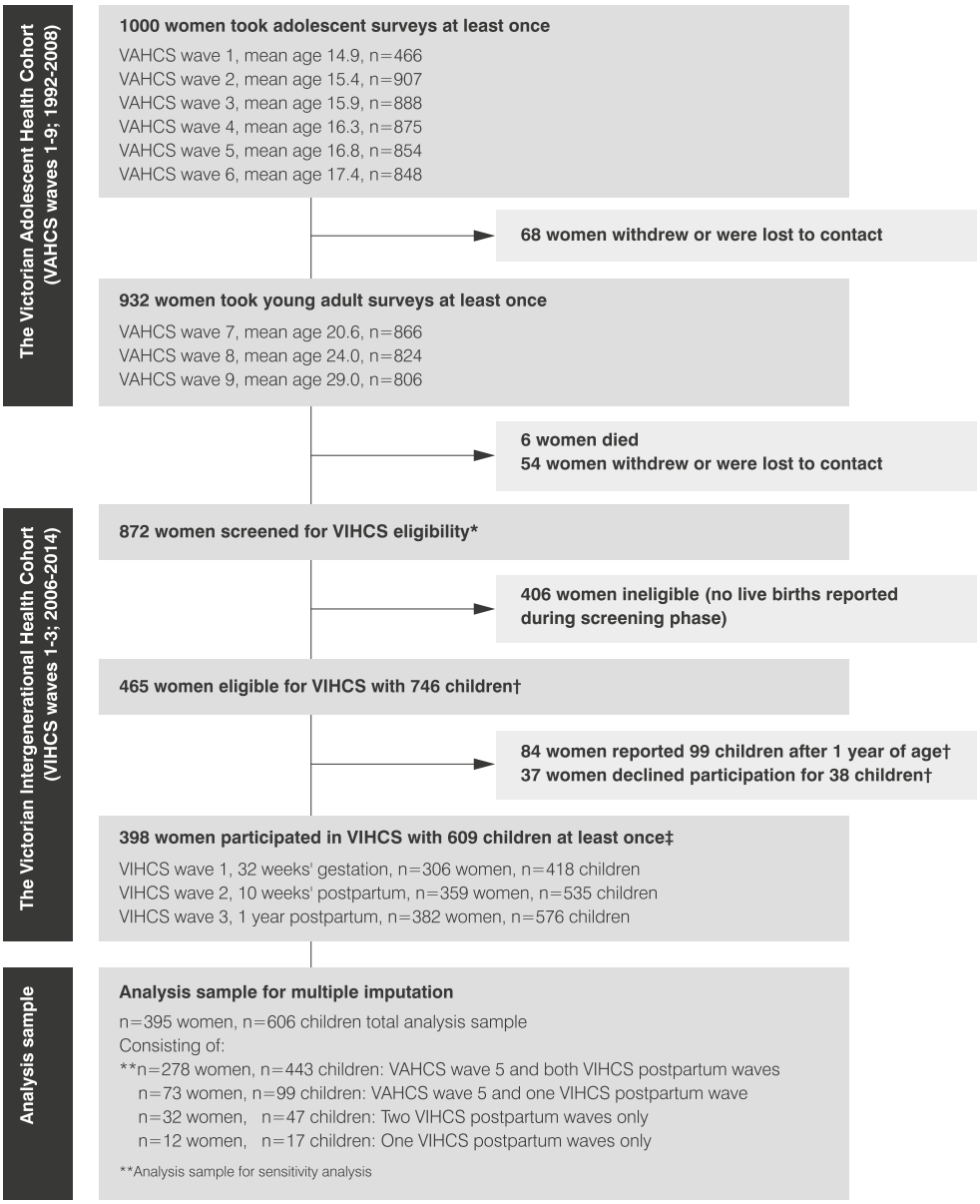

Fig. 1 Sampling and ascertainment of women in The Victorian Adolescent and Intergenerational Health Cohorts (VAHCS and VIHCS), 1992–2014

Scale items are summed for total scores with a range of 0–36 on the *care* scales and 0–39 on the *control* scales, then dichotomised in line with normed population means (mother care ≥ 27 and control ≥ 13.5; father care ≥ 24 and control ≥ 12.5) (Parker et al. 1979). As per Parker and colleagues, we used these cut-offs to define four further quadrant categories to account for heterogeneity in combinations of parental care and control: *Optimal parenting* was indicated by reports of parents' high care and low control; *Affectionate control* by high care and high control; *Affectionless control* by low care and high control; and, *Neglectful parenting* by low care and low control (Parker et al. 1979). These categories separately assessed mothers and fathers.

To understand combined effects of mothers and fathers, we derived a further two variables of care and control from mothers *plus* fathers. Using the cut-offs noted above, these care and control variables respectively had four categories represented by two high parents; two low parents; mother high and father low; and, father high and mother low.

Postnatal outcome

We assessed difficulties in maternal bonding at 2 months (mean (SD) age 10.8 (2.8) weeks) and 12 months (mean (SD) age 55 (5.6) weeks) postpartum administering the 25-item Postpartum Bonding Questionnaire (PBQ; Brockington et al. 2001) during computer-assisted telephone interviews. This scale was developed to assess the

risk of postnatal infant abuse or neglect. It has four subscales: 'general impaired bonding' (e.g. I feel happy when my baby smiles or laughs—reversed); 'rejection and anger' (e.g. I feel angry with my baby); 'caregiving anxiety' (e.g. My baby makes me feel anxious) and 'risk of abuse' (e.g. I feel like hurting my baby). Each item is scored on a 6-point scale from 0 ('always') to 5 ('never').

In previous analyses, a total score has correlated highly with the general impaired bonding factor and showed greater specificity and predictive value for bonding problems diagnosed through expert consensus using interview and case record data (Brockington et al. 2006); therefore, we used the total score but not general factor in our analyses. Responses were summed and then dichotomised to represent high and low levels of bonding problems at the following levels: total score high ≥ 16; rejection/anger high ≥ 6; caregiving anxiety ≥ 4. Validity and reliability have been demonstrated in community samples in which Cronbach's alphas for the total scaled scores ranged from 0.80 to 0.87 (Moehler et al. 2006; Reck et al. 2006; van Bussel et al. 2010). Low numbers in this community sample (n = 3) prohibited analysis of risk for abuse.

Statistical analysis

To account for the multilevel nature of the data (i.e. infants nested within mothers), we used mixed effects binary logistic regression models, with random intercepts, to test the associations between maternal adolescent–parent bonding and maternal–infant bonding at 2 and 12 months postpartum. We analysed data using Stata version 14 (StataCorp 2015). In this paper, we present model findings unadjusted and adjusted for potential confounders. These included experience of parental divorce, parental education, country of maternal birth, child sex, mother's age at childbirth and parity. In adjusted models, we tested interactions between each exposure and offspring gender. In the final presented models, we used multiple imputations to optimise the use of all available data. All presented proportions and model parameter estimates were derived from 50 imputed datasets using Rubin's rules (Rubin 1987). Our imputation followed previously outlined protocols (Patton et al. 2015). This was based on a multivariate normal model in which covariates were included as ordinal variables, whilst parental and postpartum bonding data were included as continuous variables (after zero-skew box cox transformation). After imputation, ordinal data were back transformed with adaptive rounding, and continuous variables were categorised. No interpretive differences were observed in sensitivity analyses comparing results from the imputed and complete-case datasets.

Results

Of the 872 active VAHCS female participants at the commencement of VIHCS, 465 reported pregnancies that progressed to 746 live births between 2006 and 2014. Of those, 395 (85%) women participated in at least one VIHCS postpartum assessment with 606 (81%) infant offspring (205 mothers with one infant, 170 with two infants, 19 with three infants and one with four infants). Women who did not participate had a higher prevalence of depressive symptoms at waves 7 and 9 (OR 1.98 to 2.32), of anxiety at wave 9 (OR 2.43), were more likely to be born outside Australia and to have used cannabis more frequently as a young adult (Patton et al. 2015).

Table 1 shows frequency data for total bonding problems, maternal anger/aggression, and caregiving anxiety at 2 and 12 months postpartum and for each variable indicating preconception perceptions of parent–adolescent bonding. At 2 months postpartum, 13.7% of infants' mothers reported impaired bonding (total), 4.1% reported anger/rejection and 17.2% reported caregiving anxiety. By 12 months postpartum, these proportions were 14.7, 9.6 and 7.3%, respectively. Supplementary Table 1 presents cross-tabulations between each potential confounder and the four base maternal and paternal categories of adolescent–parent bonding. Predictors did not differ by confounder categories.

Table 2 presents associations between later patterns of maternal–infant bonding and earlier adolescent perceptions of maternal and paternal *care* respectively and in combination. Low perceived paternal care, but not maternal, was associated with increased odds of overall impaired bonding with infants at 12 months postpartum (OR 3.1, 95% CI 1.1–8.6).

Table 3 presents similar associations with adolescent report of maternal and paternal *control* as the predictors. Maternal control predicted a three- to fourfold increase in the odds of overall impaired bonding (OR 3.7, 95% CI 1.4–9.7) and caregiving anxiety at 12 months (OR 3.5, 95% CI 1.1–11). It also predicted caregiving anxiety at 2 months (OR 2.1, 95% CI 1.0–4.5). Any trends for paternal control to predict postpartum bonding problems fell short of statistical significance; however, low paternal and high maternal control in combination did increase the odds of impaired bonding at 2 months (OR 5, 95% CI 1.3–20) and 12 months postpartum (OR 12, 95% CI 2.6–56), as well as caregiving anxiety at 2 months (OR 4, 95% CI 1.5–11) and 12 months postpartum (OR 8.8, 95% CI 1.8–43), and rejection/anger of the infant at 12 months postpartum (OR 4.1, 95% CI 1–16).

Table 4 compares the extent to which the four quadrant variables indicating relationships with each parent predict later maternal–infant bonding, with optimal parenting (high care/low control) as the comparator. Overall impaired bonding at 12 months was strongly predicted by both maternal (OR 5.6, 95% CI 1.3–23) and paternal affectionate control (OR 5.5,

Table 1 Frequency of postpartum bonding problems and adolescent bonding with mothers and fathers (n = 606 offspring to 395 women)

	Participants	Percent	95% Cl
Bonding outcomes—2 months postpartum			
Impaired bonding			
No	523	86.34	(83.4–89.3)
Yes	83	13.66	(10.7–16.6)
Rejection and anger			
No	581	95.90	(94.1–97.7)
Yes	25	4.10	(2.3–5.9)
Caregiving anxiety			
No	502	82.80	(79.6–86.0)
Yes	104	17.20	(14.0–20.4)
Bonding outcomes—12 months postpartum			
Impaired bonding			
No	517	85.35	(82.5–88.2)
Yes	89	14.65	(11.8–17.5)
Rejection and anger			
No	548	90.38	(88.0–92.8)
Yes	58	9.62	(7.2–12.0)
Caregiving anxiety			
No	562	92.72	(90.6–94.8)
Yes	44	7.28	(5.2–9.4)
Adolescent exposures—16 years			
Maternal care			
High	246	62.23	(58.2–66.3)
Low	149	37.77	(33.7–41.8)
Paternal care			
High	241	60.89	(56.7–65.1)
Low	154	39.11	(34.9–43.3)
Maternal control			
Low	255	64.57	(60.6–68.5)
High	140	35.43	(31.5–39.4)
Paternal control			
Low	257	65.12	(61.0–69.2)
High	138	34.88	(30.8–39.0)
Maternal care/control combinations			
Optimal parenting—maternal high care/low control	201	50.88	(46.7–55.0)
Affectionate control—maternal high care/high control	45	11.39	(8.7–14.1)
Affectionless control—maternal low care/high control	95	24.04	(20.5–27.6)
Neglectful parenting—maternal low care/low control	54	13.69	(10.8–16.6)
Paternal care/control combinations			
Optimal parenting—paternal high care/low control	191	48.39	(44.1–52.6)
Affectionate control—paternal high care/high control	49	12.50	(9.7–15.3)
Affectionless control—paternal low care/high control	88	22.38	(18.8–26.0)
Neglectful parenting—paternal low care/low control	66	16.73	(13.4–20.1)
Mother–father care—2 parent combinations			
High–high	191	48.42	(44.3–52.6)
Mother low–father high	49	12.47	(9.6–15.4)
Mother high–father low	55	13.85	(10.8–16.8)
Low–low	100	25.26	(21.6–28.9)
Mother–father control—2 parent combinations			
Low–low	213	54.04	(49.8–58.3)
Mother low–father high	42	10.52	(7.9–13.2)
Mother high–father low	44	11.08	(8.4–13.8)
High–high	96	24.36	(20.8–27.9)

Frequency estimates were calculated using imputed percentage estimates and total number of offspring for outcomes and total number of mothers of exposures

95% CI 1.3–23). Paternal affectionate control also predicted high odds for caregiving anxiety at 12 months (OR 6.7, 95% CI 1.6–28). Maternal affectionless control was predictive of impaired bonding at 12 months (OR 3.2, 95% CI 1–10). Paternal, but not maternal, neglect predicted impaired bonding at 12 months (OR 9.6, 95% CI 2.4–38), and caregiving anxiety at 2 months (OR 2.5, 95% CI 1–6) and 12 months postpartum (OR 4.4, 95% CI 1.2–17).

We assessed two-way interactions between each exposure and offspring gender at each assessment point, in fully adjusted models. None were significant at $p < 0.05$ and so were not retained in the final model.

Table 2 Unadjusted and adjusted associations between parent care at 16 years and maternal bonding problems at 2 and 12 months postpartum ($n = 606$ children born to 395 mothers)

	2 months							12 months					
				Unadjusted		Adjusted				Unadjusted		Adjusted	
	N	*n*	%	OR	95% CI	OR	95% CI	*n*	%	OR	95% CI	OR	95% CI
Impaired bonding													
Maternal care (high)	377	48	13	1.0		1.0		51	13	0.0		1.0	
Maternal care (low)	229	35	15	1.5	(0.62–3.7)	1.5	(0.60–3.6)	38	17	1.6	(0.60–4.1)	1.6	(0.61–4.3)
Paternal care (high)	369	47	13	1.0		1.0		42	11	1.0		1.0	
Paternal care (low)	237	36	15	1.4	(0.58–3.6)	1.4	(0.56–3.5)	46	20	3.0*	(1.1–8.0)*	3.1*	(1.1–8.6)*
Care combinations (high–high)	293	11	13	1.0		1.0		10	11	1.0		1.0	
Low–low	153	25	16	1.8	(0.62–5.3)	1.8	(0.60–5.1)	29	19	2.9	(0.93–9.3)	3.1	(0.94–10)
Mother low–father high	76	10	13	0.92	(0.20–4.2)	0.91	(0.20–4.1)	9	11	0.88	(0.17–4.6)	0.89	(0.17–4.7)
Mother high–father low	84	11	13	0.89	(0.21–3.8)	0.87	(0.20–3.8)	17	20	3.0	(0.76–12)	2.9	(0.71–12)
Rejection and anger													
Maternal care (high)	377	14	4	1.0		1.0		32	9	1.0		1.0	
Maternal care (low)	229	11	5	1.7	(0.26–11)	1.8	(0.22–15)	26	11	1.6	(0.64–3.9)	1.6	(0.64–3.8)
Paternal care (high)	369	14	4	1.0		1.0		34	9	1.0		1.0	
Paternal care (low)	237	11	4	1.3	(0.19–8.2)	14	(0.17–11)	24	10	1.2	(0.51–2.9)	1.3	(0.52–3.0)
Care combinations (high–high)	293	3	4	1.0		1.0		7	8	1.0		1.0	
Low–low	153	8	5	1.8	(0.22–15)	1.99	(0.18–22)	16	11	1.5	(0.53–4.5)	1.6	(0.54–4.6)
Mother low–father high	76	2	3	0.4	(0.01–16)	0.38	(0.01–18)	9	13	1.8	(0.47–7.0)	1.8	(0.47–7.0)
Mother high–father low	84	2	2	0.2	(0.01–10)	0.22	(0.00–15)	8	9	1.1	(0.29–4.5)	1.2	(0.31–4.9)
Caregiving anxiety													
Maternal care (high)	377	61	16	1.0		1.0		26	7	1.0		1.0	
Maternal care (low)	229	44	19	1.3	(0.71–2.5)	1.4	(0.69–2.8)	18	8	1.3	(0.46–3.7)	1.3	(0.47–3.7)
Paternal care (high)	369	54	15	1.0		1.0		24	7	1.0		1.0	
Paternal care (low)	237	50	21	1.7	(0.92–3.1)	1.7	(0.88–3.5)	20	8	1.4	(0.51–4.1)	1.3	(0.47–3.8)
Care combinations (high–high)	293	12	15	1.0		1.0		5	6	1.0		1.0	
Low–low	153	33	22	1.8	(0.86–3.7)	1.9	(0.83–4.2)	12	8	1.5	(0.43–5.4)	1.5	(0.41–5.1)
Mother low–father high	76	11	14	0.94	(0.32–2.7)	0.91	(0.28–2.9)	6	8	1.3	(0.27–6.6)	1.3	(0.27–6.4)
Mother high–father low	84	17	21	1.5	(0.62–3.6)	1.5	(0.56–3.9)	8	9	1.6	(0.34–7.3)	1.3	(0.28–6.3)

205 women with one child, 170 women with two children, 19 women with three children and 1 woman with four children. Significant associations are shown with an asterisk. At 2 months, estimates of rejection/anger for parental care combinations are based on $n = 46$ imputations due to 0 cell counts in 3 imputed datasets. Adjustments were for parental divorce, parental education, country of maternal birth, child sex, mother's age at childbirth and parity

In total, 16 results were found to be statistically significant in fully adjusted models, 12 remained statistically significant after addressing the issue of multiple comparisons by controlling the false discovery rate (FDR) to be 25%, using the method presented by Benjamini and Hochberg (1995). The effects that did not hold as statistically significant after FDR adjustment were the prediction of caregiving anxiety at 2 months by maternal control ($p = 0.040$) and neglectful parenting ($p = 0.041$), the prediction of rejection/anger at 12 months by high mother/low father control ($p = 0.046$) and total impaired bonding at 12 months by affectionless control ($p = 0.048$).

Discussion

An adolescent girl's perceptions of her bond with her father and mother differentially predict risk for maternal–infant bonding problems when she becomes a parent. In our study, perceived low care and neglect from fathers, but not mothers, at 16 years, predicted subsequent maternal–infant bonding problems; whereas from mothers, high control predicted risk of next-generation bonding problems. Furthermore, women who reported high maternal control in combination with low paternal control were at increased risk for all maternal bonding problems,

Table 3 Unadjusted and adjusted associations between parent control at 16 years and maternal bonding problems at 10 weeks and 12 months postpartum (n = 606 children born to 395 mothers)

	2 months							12 months					
				Unadjusted		Adjusted				Unadjusted		Adjusted	
	N	*n*	%	OR	95% CI	OR	95% CI	*n*	%	OR	95% CI	OR	95% CI
Impaired bonding													
Maternal control (low)	391	44	11	1.0		1.0		42	11	1.0		1.0	
Maternal control (high)	215	39	18	2.5	(0.99–6.2)	2.3	(0.90–5.7)	46	22	3.5*	(1.4–8.9)*	3.7*	(1.4–9.7)*
Paternal control (low)	395	56	14	1.0		1.0		53	13	1.0		1.0	
Paternal control (high)	211	27	13	0.91	(0.36–2.3)	0.89	(0.35–2.2)	36	17	1.6	(0.60–4.1)	1.6	(0.59–4.1)
Control combinations (low–low)	328	37	11	1.0		1.0		31	10	1.0		1.0	
Mother low–father high	64	7	11	1.0	(0.21–4.8)	1.0	(0.20–4.8)	11	18	3.0	(0.72–12)	(3.0)	(0.71–13)
Mother high–father low	67	19	28	5.7*	(1.5–22)*	5.0*	(1.3–20)*	22	32	11*	(2.5–45)*	12*	(2.6–56)*
High–high	148	9	14	1.5	(0.51–4.4)	1.4	(0.48–4.2)	11	17	2.5	(0.86–7.3)	2.6	(0.85–7.7)
Rejection and anger													
Maternal control (low)	391	14	4	1.0		1.0		33	9	1.0		1.0	
Maternal control (high)	215	11	5	2.5	(0.36–18)	2.4	(0.26–21)	25	12	1.7	(0.68–4.1)	1.6	(0.65–4.0)
Paternal control (low)	395	15	4	1.0		1.0		35	9	1.0		1.0	
Paternal control (high)	211	10	5	1.8	(0.27–12)	2.0	(0.23–18)	23	11	1.4	(0.58–3.3)	1.4	(0.59–3.4)
Control combinations (low–low)	328	10	3	1.0		1.0		24	7	1.0		1.0	
Mother low–father high	64	4	6	4.5	(0.26–80)	6.8	(0.19–246)	10	16	3.2	(0.87–12)	3.4	(0.90–13)
Mother high–father low	67	5	8	7.2	(0.40–128)	8.0	(0.22–291)	12	17	4.2*	(1.1–16)*	4.1*	(1.0–16)*
High–high	148	3	4	2.2	(0.20–23)	2.3	(0.15–35)	6	9	1.4	(0.49–4.1)	1.4	(0.48–4.2)
Caregiving anxiety													
Maternal control (low)	391	55	14	1.0		1.0		20	5	0.0		1.0	
Maternal control (high)	215	49	23	2.1*	(1.1–3.9)*	2.1*	(1.0–4.5)*	24	11	3.3*	(1.1–10)*	3.5*	(1.1–11)*
Paternal control (low)	395	65	16	1.0		1.0		26	7	1.0		1.0	
Paternal control (high)	211	39	19	1.2	(0.63–2.4)	1.2	(0.58–2.5)	18	9	1.7	(0.59–4.7)	1.7	(0.59–4.7)
Control combinations (low–low)	328	44	13	1.0		1.0		14	4	1.0		1.0	
Mother low–father high	64	11	18	1.5	(0.52–4.2)	1.5	(0.45–4.7)	7	10	3.2	(0.74–14)	3.2	(0.71–14)
Mother high–father low	67	21	32	3.7*	(1.5–9.1)*	4.0*	(1.5–11)*	12	18	8.3*	(1.8–38)*	8.8*	(1.8–43)*
High–high	148	13	19	1.7	(0.78–3.6)	1.7	(0.72–4.0)	5	8	2.6	(0.76–8.9)	2.7	(0.78–9.5)

205 women with one child, 170 women with two children, 19 women with three children and 1 woman with four children. Significant associations are shown with an asterisk. Adjustments were for parental divorce, parental education, country of maternal birth, child sex, mother's age at childbirth and parity

and were the only group with elevated risk of felt anger and rejection toward their infants. Perceived affectionate control from either parent, and affectionless control from mothers, also clearly predicted overall impaired maternal–infant bonding.

Our finding that perceived low care or neglect from fathers increases risk for next generation mother-to-infant bonding problems adds to a growing body of evidence on the importance of father availability in shaping the reproductive-caregiving futures of their daughters (Bogaert 2005; Tither and Ellis 2008). A caring father's presence can signal longevity of father investment and provides a model for an adaptive family environment. It plausibly reassures a new mother of a male partner's ongoing involvement in the protection and rearing of her offspring.

For mothers, we found a different intergenerational process whereby high control predicted subsequent maternal bonding problems. Controlling, overprotecting behaviour indicates distrust in the adolescent's capacity to competently care for herself. It may undermine the normative identity shift between adolescence and adulthood from a receiver of care to a caregiver (Soenens and Vansteenkiste 2010). It seems plausible that as the traditional primary caregiver and role model of nurturing parenting behaviour, a mother's negation of her daughter's competence to care for herself can have a

Table 4 Unadjusted and adjusted associations between parent care and control combinations at 16 years and maternal bonding problems at 2 months and 12 months postpartum (n = 606 children born to 395 mothers)

	2 months							12 months					
				Unadjusted		Adjusted				Unadjusted		Adjusted	
	N	*n*	%	OR	95% CI	OR	95% CI	*n*	%	OR	95% CI	OR	95% CI
Impaired bonding													
Mother parenting													
Optimal parenting	308	36	12	1.0		1.0		32	10	1.0		1.0	
Affectionate control	69	12	18	2.4	(0.61–9.2)	2.0	(0.50–7.7)	19	27	5.5*	(1.4–22)*	5.6*	(1.3–23)*
Affectionless control	146	27	18	2.5	(0.84–7.3)	2.3	(0.79–6.9)	28	19	3.0	(0.98–9.1)	3.2*	(1.0–10)*
Neglectful parenting	83	14	10	0.94	(0.24–3.6)	0.88	(0.22–3.5)	18	12	1.3	(0.33–5.4)	1.3	(0.32–5.5)
Father parenting													
Optimal parenting	293	33	11	1.0		1.0		25	9	1.0		1.0	
Affectionate control	76	14	18	2.3	0.60–8.6	2.1	(0.56-7.9)	17	23	4.9*	(1.3-19)*	5.5*	(1.3-23)*
Affectionless control	136	13	10	0.91	0.26–3.1	0.9	(0.26-3.2)	19	14	2.4	(0.74-7.6)	2.3	(0.71-7.7)
Neglectful parenting	101	30	22	3.3*	(1.0–10)*	3.1	(0.97–10)	37	27	8.1*	(2.2–29)*	9.6*	(2.4–38)*
Rejection and anger													
Mother parenting													
Optimal parenting	308	11	4	1.0		1.0		24	8	1.0		1.0	
Affectionate control	69	3	4	1.5	(0.08–26)	1.2	(0.05–28)	8	12	2.1	(0.53–8.0)	1.9	(0.48–7.4)
Affectionless control	146	8	6	2.8	(0.29–28)	2.8	(0.23–35)	17	11	1.9	(0.62–5.5)	1.8	(0.61–5.4)
Neglectful parenting	83	4	3	0.69	(0.03–17)	0.73	(0.02–23)	16	11	1.8	(0.48–6.6)	1.8	(0.47–6.5)
Father parenting													
Optimal parenting	293	10	3	1.0		1.0		22	8	1.0		1.0	
Affectionate control	76	5	6	4.2	(0.27–66)	4.7	(0.20–112)	12	16	2.9	(0.84–10)	3.1	(0.87–11)
Affectionless control	136	5	4	1.5	(0.13–17)	1.8	(0.11–29)	11	8	1.2	(0.40–3.7)	1.3	(0.41–3.9)
Neglectful parenting	101	7	5	2.3	(0.16–32)	2.6	(0.12–59)	17	13	2.2	(0.67–7.0)	2.4	(0.68–8.4)
Caregiving anxiety													
Mother parenting													
Optimal parenting	308	45	14	1.0		1.0		17	6	1.0		1.0	
Affectionate control	69	16	23	2.0	(0.80–5.0)	1.9	(0.68–5.2)	8	12	3.3	(0.73–15)	3.4	(0.73–16)
Affectionless control	146	33	23	2.0	(0.96–4.3)	2.2	(0.93–5.0)	15	11	2.8	(0.79–9.6)	2.9	(0.82–10)
Neglectful parenting	83	19	13	0.86	(0.30–2.4)	0.81	(0.26–2.5)	5	3	0.50	(0.07–3.5)	0.45	(0.06–3.3)
Father parenting													
Optimal parenting	293	39	13	1.0		1.0		12	4	1.0		1.0	
Affectionate control	76	15	20	1.8	(0.70–4.7)	1.6	(0.57–4.6)	12	16	7.1*	(1.7–29)*	6.7*	(1.6–28)*
Affectionless control	136	24	18	1.5	(0.69–3.4)	1.6	(0.65–3.8)	6	5	1.2	(0.30–5.1)	1.2	(0.29–4.9)
Neglectful parenting	101	35	26	2.6*	(1.2–5.7)*	2.5*	(1.0–6.0)*	18	13	5.0*	(1.4–19)*	4.4*	(1.2–17)*

Parental bonding instrument combinations are the following: Optimal parenting = high care/low control; affectionate control = high care/high control; affectionless control = low care/high control; neglectful parenting = low care/low control. Significant associations are shown with an asterisk. Adjustments were for parental divorce, parental education, country of maternal birth, child sex, mother's age at childbirth and parity

particularly profound influence on the development of a self-concept that includes caring for and protecting others. Our outcome instrument was developed to indicate parent–child *attachment* relationships and this interpretation is congruous with that framework.

When we examined combinations of maternal and paternal care and control, parental affectionate control was the clearest antecedent of postpartum bonding problems common to adolescent relationships with both parents. It is plausible that susceptibility to parental control is enhanced when

it is cloaked in overt displays of warmth and support. In examination of combined mother and father relationships, we found that high maternal control coupled with low paternal control predicted impaired bonding and caregiving anxiety at 2 months. By 12 months postpartum, this combination predicted all bonding outcomes and was the only clear predictor of maternal anger and rejection. High maternal control combined with low paternal control in adolescence may be indicative of parental conflict and parenting inconsistency. It may likewise represent a magnified effect of a mother's overprotecting behaviours in a context of paternal distance or neglect. Either way, previous research has shown contrary styles of parenting to undermine family functioning and child development (Simons and Conger 2007).

In previous studies, perceived care and control as measured by the PBI have been associated with a range of mental health problems (Enns et al. 2002; Patton et al. 2001). It is therefore possible that adolescent girls with mental health concerns report particular parental relationship patterns that predict subsequent maternal bonding problems. However, two 20-year longitudinal studies of the PBI found it to be stable and resistant to mood state (Murphy et al. 2010; Wilhelm et al. 2005), suggesting it unlikely that our participant reports are attributable primarily to adolescent mental health. Given the transactional nature of relationship and mental health pathways, a proper address of this possibility would require a study design with repeated measures of both mental health and parental bonding across adolescence. Additionally, self-reported bonding might reflect personality, which is only partly determined by relationships with parents; however, previous research has detected only weak correlations (Pearson's $r = -0.22$ to 0.22) between neuroticism and intra-individual variation in PBI scores across four time points and 20 years (Wilhelm et al. 2005).

At 2 and 12 months postpartum, intergenerational trends were in a similar direction. However, most effects were not clearly established until 12 months, indicating a process of progressive mother–infant dyadic adjustment. It also suggests a window of opportunity in the first year postpartum to counter intergenerational risk and promote adaptive mother–infant interactions characterised by emotional availability (Bornstein et al. 2012).

A strength of this study was its prospective design. Overall attrition has been low in VIHCS; however, 14% of VAHCS women who reported live births in the recruitment period did not participate. This group were more likely to be born outside Australia and demonstrated differing patterns of cannabis use and mental health problems before conception (Patton et al. 2015). Multiple imputations optimised our use of the study data and reduced potential participation biases but cannot fully address biases from differential non-participation.

We conducted multiple comparisons and contend that the low prevalence of bonding problem outcomes warranted maintaining the threshold for significance at the standard 95% confidence intervals. Nevertheless, we adjusted for the possibility of false discovery and found four associations did not hold as significant. We suggest these tests, at the more stringent level, were underpowered. Moreover, the pattern of results was both theoretically explainable and consistent across similar analyses.

While our data were prospective, the PBI is argued to capture retrospective perceptions across the first 16 years; however, we cannot state with certainty that problems reported at 16 years were present in childhood or earlier adolescence. Available data also only allowed for examination of maternal intergenerational pathways. Investigations of paternal postpartum bonding antecedents are also warranted. We also did not capture data on whether the parents of adolescents were biological, adoptive, step or other parental figures. Future researchers are encouraged to consider whether parents' biological status influences these associations.

Our findings suggest that strategies to promote maternal–infant bonding should begin well before pregnancy. Developmental interventions in adolescence or prior that enhance attachment relationships present an opportunity to improve quality of life for young people, but also potentially disrupt embedded intergenerational cycles of relationship dysfunction and their associated mental health outcomes (Kobak et al. 2015). Benefits of public health and clinical investment in strengthening the quality of parent–adolescent relationships are therefore twofold; providing short-term gain, and safe-guarding next generation early development.

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Compliance with ethical standards All procedures performed in studies involving human participants were in accordance with the ethical standards of the institutional and/or national research committee and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards. Informed consent was obtained from all individual participants included in the study.

Conflict of interest All authors declare that they have no conflict of interest.

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