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ORIGINAL ARTICLE

Continuity of midwifery carer moderates the effects of prenatal maternal stress on postnatal maternal wellbeing: the Queensland flood study

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Abstract Poor postnatal mental health is a major public health issue, and risk factors include experiencing adverse life events during pregnancy. We assessed whether midwifery group practice, compared to standard hospital care, would protect women from the negative impact of a sudden-onset flood on postnatal depression and anxiety. Women either received midwifery group practice care in pregnancy, in which they were allocated a primary midwife who provided continuity of care, or they received standard hospital care provided by various on-call and rostered medical staff. Women were pregnant when a sudden-onset flood severely affected Queensland, Australia, in January 2011. Women completed questionnaires on their flood-related hardship (objective stress), emotional reactions (subjective stress), and cognitive appraisal of the impact of the flood. Self-report assessments of the women's depression and anxiety were obtained during pregnancy, at 6 weeks and 6 months postnatally. Controlling for all main effects, regression analyses at 6 weeks postpartum showed a significant interaction between maternity care type and objective flood-related hardship and subjective stress, such that depression scores increased with increasing objective and subjective stress with standard care, but not with midwifery group practice (continuity), indicating a buffering effect of continuity of midwifery carer. Similar results were found for anxiety scores at 6 weeks, but only with subjective stress. The benefits of midwifery continuity of carer in pregnancy extend beyond a more positive birth experience and better birthing and infant outcomes, to mitigating the effects of high levels of stress experienced by women in the context of a natural disaster on postnatal mental health.

Keywords Prenatal maternal stress · Postnatal depression · Anxiety · Midwifery group practice · Natural disaster · Continuity of carer

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Introduction

A large literature documents poor postnatal maternal mental health as a serious public health issue with negative consequences for the woman, her family, and her child's development (Glasheen et al. 2010; O'Hara and McCabe 2013; Saulnier and Brolin 2015; Stein et al. 2014). These ill effects are evident in pregnancy and extend well into the postnatal period and for years afterward (O'Hara and McCabe 2013; Stein et al. 2014). Between 12 and 15% of Australian women experience depression in the first 6 months postpartum, with a 9.3% 1-year period prevalence rate of major depression for postpartum women. The prevalence of diagnosed depression among mothers of children aged 24 months or less is thought to be around 20% (Australian Institute of Health Welfare 2012). Although anxiety in the perinatal period is common, for example, 13% prevalence in Australian women 6-months

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postnatally (Yelland et al. 2010), with high comorbidity with depression (Austin et al. 2010), it has received less attention than postnatal depression (Howard et al. 2014). Between 4 and 20% of women are reported to experience an anxiety disorder in the postpartum period, highlighting a lack of consistency in definitions and reporting (Leach et al. 2015).

Risk factors for postpartum mental health disorders include history of psychiatric disorder, antenatal depression, poor social support or marital distress, young age, and lower socioeconomic status (Beck 2001; Grant et al. 2008; Milgrom et al. 2008). Acute or chronic stress in pregnancy is also highly predictive of perinatal mental health problems (Leach et al. 2015; Lee et al. 2007; O'Hara and Swain 1996; O'Hara et al. 1991). A small body of research has focused on the role of severe stress in pregnancy and postnatal mental health. This research shows that experiencing a natural disaster in pregnancy (e.g. hurricane (Xiong et al. 2008), flood (Brock et al. 2015), or war (Kleinhaus et al. 2013) predicts poor perinatal mental health, but perhaps not worse than in the general population (Harville et al. 2009). The stress caused by natural disasters can vary depending on the degree to which pregnant women are affected (objective hardship) as well as the intensity of the women's emotional response (subjective stress) (Dancause et al. 2011; Hilmert et al. 2016). A systematic review reported that the severity of exposure to a disaster in pregnancy predicts negative mental health outcomes (Harville et al. 2010).

Social support from the partner during pregnancy has been found to protect against the negative effects of a severe stressor on women's postnatal mental health: women who had infrequent support during pregnancy experienced greater objective stress and less reduction in depressive symptoms following a disaster, while frequent support weakened the association between stress and depression (Brock et al. 2014; Tees et al. 2010). Social support from midwives may provide similar protection. Women who receive continuity of midwifery carer during pregnancy, birth, and the postnatal period, where a small team of midwives work together in a midwifery group practice (MGP), report increased support when compared to women in standard care (SC) models (Forster et al. 2016). Although continuity of midwifery carer has been shown to significantly improve birth outcomes for women when compared to SC (Sandall et al. 2016), it is not known whether MGP is able to buffer the negative effects that prenatal maternal stress (PNMS) can have on maternal postnatal wellbeing.

The present study

In January 2011, Brisbane experienced a devastating sudden-onset flood that killed 24 people and adversely affected 200,000 residents, costing the State over $AU2 billion (van den Honert and McAneney 2011). We capitalised on this natural disaster to examine the potentially protective role of continuity of midwifery carer on women's postnatal mental health outcomes. We hypothesised that MGP care, when compared to SC, would protect pregnant women from the impact of objective levels of flood exposure and subjective levels of maternal flood-related distress on depression and anxiety at 6 weeks and 6 months postpartum.

Methods

Study design and setting

The 2011 Queensland Flood Study (QF2011), a longitudinal cohort study (King et al. 2015), piggy-backed on an established, randomised control trial (RCT) examining the impact of caseload MGP care versus SC on birth outcomes: the M@NGO trial (Tracy et al. 2011, 2013). Recruitment commenced once ethical approval was received (April 4, 2011) and continued to 1 year post-flood (mid-January 2012) at a major tertiary hospital in South Brisbane, Australia. Women completed a survey at recruitment into the study, and follow-up surveys were administered at 12 months post-flood and at 6 weeks and 6 months postpartum. A more detailed description of the QF2011 protocol is presented in King et al. (2015), and the M@NGO trial protocol is published in Tracy et al. (2011).

Participants

Eligibility criteria included living in the vicinity of Brisbane and being pregnant with a singleton pregnancy at the peak of the Queensland flood in January 2011, being over 18 years of age, and able to speak fluent English (King et al. 2015). Women who were already enrolled in the ongoing M@NGO RCT of pregnancy care (Tracy et al. 2013) were invited to also enrol in the QF2011 study if they met eligibility criteria. New women recruited into M@NGO were also invited to participate in the QF2011 study, as well as women who did not meet M@NGO eligibility (e.g. < 24 weeks pregnant). Recruitment was primarily face-to-face at antenatal appointments by midwives and research assistants (RAs) with additional advertisements placed in local media and doctors' offices. All women were pregnant during the flood, and those outside of the M@NGO trial were already allocated to a model of care prior to recruitment in the study (thus could not be randomised). A total of $N = 38$ were pregnant and $N = 88$ had already birthed when recruited into QF2011. There were two groups of participants: women enrolled in both M@NGO and QF2011 ($n = 80$) and women enrolled in QF2011 only ($n = 46$). Due to the nature of the intervention neither the women themselves nor the care providers were blind to the intervention. All

women were contacted by RAs for maternal and infant follow-up surveys; the RAs were blinded to care group allocation.

Maternity care groups

M@NGO participants were randomly assigned to either MGP or SC care, whereas the QF2011-only women self-selected their care type, or were allocated into MGP if places were available. The care type each woman received most during her pregnancy was considered her 'model of care'. Care providers are documented at every antenatal visit in the women's records and were all verified by research midwives. In MGP, women were assigned to a primary caseload midwife that worked within a team of four full-time midwives who self-manage their schedules to respond to the needs of the women under their care. They provided continuity of care through the antenatal, intrapartum, and postpartum periods, and their MGP practice partners provided back-up care if the primary midwife was on leave or had worked more than 12 continuous hours. Not all women received care in labour from a known midwife however with the M@NGO trial finding that 87% of participants had their known midwife or her back up in the caseload arm compared to 14% in SC (Tracy et al. 2013). MGP midwives provided a home-visiting support service up to 6 weeks postpartum. In the SC model, women received shared care from a community-based general practitioner for antenatal care, and/or hospital midwives and/or hospital doctors through antenatal clinics, birth suites, and postnatal wards. Thus, SC group women could receive care from different rostered doctors or midwives at each hospital visit. Some SC women chose the option to be discharged home early from hospital (before 48 h for vaginal birth and 72 h for caesarean section), which entitled them to a home visit from a domiciliary midwife (although some women only received a phone call). If a woman required more than one visit, it may have been from different midwives, which can also happen in the caseload model when midwives need to take unexpected leave, have worked long shifts, and are on a fatigue break or leave the program. The key differences between the models is the continuity that enables relationships to develop between women and their midwives and the 24/7 phone contact to a known midwife that is enabled in the caseload model. All routinely collected data during the maternity period is entered into an electronic database with each woman having a unique identifier.

Instruments

Prenatal maternal stress

Objective stress exposure At recruitment and 12 months post-flood objective hardship was assessed with the Queensland Flood Objective Stress Scale (QFOSS), a questionnaire tailored specifically for the Queensland flood event. Four key dimensions of stress from previous disaster-related PNMS studies were assessed: threat, loss, scope, and change. Each dimension had scores ranging from 0 (no impact) to 50 (extreme impact) and were summed to provide a total objective stress score, (range = 0–200); higher scores indicated higher levels of objective hardship.

Subjective stress Three separate instruments were administered at recruitment to assess the women's subjective distress from the floods. The 22-item Impact of Event Scale – Revised (IES-R; Weiss and Marmar 1997) assessed post-traumatic-like symptoms in response to the flood during the preceding 7 days. The 13-item Peritraumatic Distress Inventory (PDI; Brunet et al. 2001) assessed women's recollection of emotional distress and panic-like reactions experienced during the flood. And the 10-item Peritraumatic Dissociation Experience Questionnaire (PDEQ; Marmar et al. 1997) assessed the severity of dissociative-like experiences during the flood. To minimise the number of predictor variables, the three subjective stress scores were combined into the COmposite Score for MOthers' Subjective Stress (*COSMOSS*). This composite variable is standardised, so a positive COSMOSS score represents a level of subjective stress higher than the group mean. The COSMOSS was calculated using principal component analysis (PCA) on IES-R, PDI, and PDEQ total scores from the initial 230 participants who provided PNMS data at recruitment. The PCA-derived algorithm was COSMOSS = 0.36 × IESR + 0.40 × PDI + 0.39 × PDEQ. The PCA resulted in one factor explaining 76.27% of the overall subjective stress variance.

Cognitive appraisal At recruitment, the women's cognitive appraisal of the overall impact of the flood was assessed with the question: 'If you think about all of the consequences of the 2011 Queensland flood on you and your household, would you say the flood has been…?' Women rated their appraisal on a 5-point Likert scale, from very negative (− 2) to very positive (+ 2). Due to the narrow range of responses, and to determine the impact of a negative cognitive appraisal, this item was dichotomized into 'Negative' and 'Neutral/Positive'.

Maternal well-being

At the antenatal hospital registration visit (at around 14 weeks), and 6 weeks and 6 months postnatally, women completed the 10-item Edinburgh Postnatal Depression Scale (EPDS; Cox et al. 1987) to assess women's emotional distress over the previous 7 days. Consistent with guidelines, women who scored above 12 on the EPDS, or who indicated self-harm intentions, were contacted by study RAs and offered referral.

At 6 weeks and 6 months, postnatally women completed the state scale of the State Trait-Anxiety Inventory (SAI; Spielberger et al. 1983) to assess their current level of anxiety.

Socioeconomic status and other pregnancy life events

To characterise *socioeconomic status* (SES) based on residence, we obtained each participant's Economic Indexes For Area (SEIFA) score, which indicates the socioeconomic characteristics of neighbourhoods in Australia (M = 1000; SD = 100); higher scores indicate that an area is relatively advantaged compared to lower scores. *Other major life events experienced in pregnancy* were assessed using a modified version of the Life Experiences Survey (LES; Sarason et al. 1987), which describes 26 categories of life events (e.g., divorce, illness). The total number of life events was used here.

Statistical methods

We examined whether type of maternity care (MGP vs. SC) interacted with flood-related PNMS to explain variance in postnatal depression and anxiety at 6 weeks and 6 months, controlling for socioeconomic status, other life events in pregnancy, and depression in pregnancy. The following variables were sequentially entered into the regression models: (1) SEIFA score; (2) the number of stressful events during pregnancy; (3) EPDS at hospital registration; (4) care type: SC (= 0) vs. MGP care (= 1); (5) objective stress; (6) subjective stress or cognitive appraisal; and (7) interaction term between model of maternity care and each PNMS variable. Given the moderate sample size, we assessed the effects of different PNMS variables one by one in each model, always with adjustment for objective stress. Thus, three models were constructed for each of the four outcomes (depression and anxiety, at 6 weeks and 6 months), each one testing the interaction between model of maternal care (MGP vs. SC) and the three PNMS variables (objective, subjective, cognitive).

To assess and compare the effects of the potential predictors, in addition to the effect estimates (point estimate, standard error, and 95% confidence interval) and their significance, we calculated the proportion of the variance in the outcome variable explained by each variable at its entry, over and above that already explained by other variables already in the model, as well as the coefficients for the final model. All analyses used two-tailed tests with a significance level of 0.05 and were performed using SAS version 9.3 (SAS Institute; Cary, NC).

Results

There were 196 women who had depression and anxiety data at 6 weeks and/or 6 months. Each analysis only included women with complete data for all variables in the equation. Women were missing data for stressful life events in pregnancy (n = 37) and depression scores at hospital registration (n = 36). The mean gestation for hospital registration EPDS screening was 14.52 weeks with interquartile range 12.29–15.57. At 6 weeks postpartum, the analyses included 48 women in MGP and 54 in SC, and at 6 months, there were 65 in MGP and 53 in SC. Women with recruitment questionnaires were invited to participate at all stages of data collection and were not excluded if they missed earlier data collection points which explains the higher number of participants at the later time point.

At 6 weeks postpartum, the average number of at-home visits from a midwife after the birth was 5.93 (n = 43; SD = 2.24, range = 2–12) for MGP women and 1.90 (n = 49; SD = 1.29, range = 0–6) for SC women, a significant group difference (t = − 10.38, p value < 0.0001).

Table 1 shows the descriptive statistics for women in MGP and SC care models; there were no statistically significant group differences.

Maternal depression Table 2 shows the results from the six multivariable hierarchical linear models for predicting postnatal depression 6 weeks and 6 months postpartum with interactions between care type and objective hardship (model 1), cognitive appraisal (model 2), or subjective stress (model 3).

In all six models, there was a significant main effect of depression at hospital registration (explaining 26% of unique variance at 6 weeks, and 16% at 6 months), such that greater EPDS scores in early pregnancy predicted greater postnatal depression scores at both time periods.

Objective hardship In model 1, controlling for all main effects, there was a significant interaction between maternity care type and objective hardship that explained an additional 3.3% of variance in 6-week depression scores. As illustrated in Fig. 1, although there was no effect of objective hardship from the flood on depression in the MGP group, for women in SC, the more severe the objective hardship the greater their postpartum depression. Although there were no group differences in depression at low levels of objective hardship, depression was significantly more severe in the SC when objective hardship was 22 or greater, or approximately one quarter of a SD above the mean. The final model explained 36.0% of the variance in 6-week depression scores. For 6-month depression, only stressful life events and pregnancy depression were significant predictors, with the final model explaining 26.4% of variance.

Cognitive appraisal Table 2, model 2, shows that the interaction between cognitive appraisal and maternity care type was non-significant. This model explained 35% of the variance in 6-week depression scores. At 6 months, significant

Table 1 Descriptive statistics of study participants in MGP care and standard care models, and significance of independent group *t* tests

	MGP care (n = 55) Mean (SD) [Range]	Standard care (n = 71) Mean (SD) [Range]	P value
Mother's age at infant's birth	30.81 (4.61) [20.54–47.33]	31.38 (5.25) [19.52–40.06]	0.53
SEIFA score	1044.38 (56.74) [902–1127]	1052.87 (55.08) [856–1125]	0.40
Stressful life events in pregnancy	2.07 (2.52) [0–12]	1.41 (1.88) [0–8]	0.11
Pregnancy depression score (EPDS)	4.40 (3.21) [0–14]	4.92 (3.95) [0–14]	0.43
Postnatal depression score (EPDS)			
6 weeks (N = 102)	4.37 (3.77) [0–15]	5.81 (4.83) [0–19]	0.10
6 months (N = 118)	6.42 (4.58) [0–19]	5.40 (4.17) [0–20]	0.21
Postnatal anxiety score (STAI)			
6 weeks (N = 102)	31.97 (8.08) [19–50]	34.01 (10.03) [20–63]	0.27
6 months (N = 118)	34.69 (9.00) [20–60]	32.38 (8.69) [20–59]	0.16
Objective hardship (QFOSS)[a]	19.04 (14.92) [3–62]	17.83 (16.47) [2–74]	0.67
Subjective stress			
PTSD symptoms (IES-R)[b]	5.78 (8.37) [0–33]	5.25 (9.47) [0–45]	0.41
Peritraumatic distress (PDI)[c]	12.35 (8.00) [1–32]	10.58 (7.40) [0–32]	0.19
Peritraumatic dissociation (PDEQ)[d]	6.65 (7.65) [0–32]	5.34 (7.34) [0–32]	0.10
Composite subjective stress (COSMOSS)	0.04 (0.95) [− 1.03–2.62]	− 0.13 (0.90) [− 1.08–2.74]	0.31
Cognitive appraisal (N, %)			
Negative	16 (29.09%)	26 (37.15%)	0.34
Neutral or positive	39 (70.91)	44 (62.86%)	
Pregnancy flood exposure (days pregnant)	124.25 (79.58) [1–263]	120.33 (71.68) [0–264]	0.77
Pregnancy flood exposure (weeks pregnant)	17.75 (11.36) [0.14–37.57]	17.19 (10.24) [0–37.71]	

[a] QFOSS 0–200

[b] IES-R 0–88

[c] PDI 0–52

[d] PDEQ 0–40

effects were found only for life events and pregnancy depression, with the final model explaining 28.6% of the variance.

Subjective stress As shown in Table 2, model 3 explained 42.3% of the variance in 6-week depression. There was a significant interaction between care type and subjective flood-related stress which explained an additional 4.7% of variance. As illustrated in Fig. 2, although in the SC group the greater the flood-related subjective stress, the greater the depression (p < .05), MGP care buffered the effects of disaster-related subjective stress on depression at 6 weeks. Although there was little difference in depression scores when flood-related subjective stress was low, when stress levels were greater than 0.095 (meaning 9.5% of one standard deviation above the mean), depression in the SC group was significantly greater than that in the MGP group. For depression at 6 months postpartum, there was a significant, positive main effect of subjective stress,

Table 2 Three multivariable linear models for predicting postnatal maternal depression score at 6 weeks and 6 months, for (1) objective hardship, (2) cognitive appraisal, and (3) subjective stress. Coefficients are for the final model

		6 weeks (48 MGP, 54 SC)					6 months (65 MGP, 53 SC)				
	Predictors	Regression coefficient				Variance explained (%)[b]	Regression coefficient				Variance explained (%)[b]
		Point estimate	Standard error	95% CI[a]	*p* value		Point estimate	Standard error	95% CI[a]	*p* value	
Model 1	Socioeconomic status	0.01	0.01	[− 0.01; 0.02]	0.212	1.09	0.01	0.01	[− 0.01; 0.02]	0.388	0.72
	Stressful life events in pregnancy	0.18	0.17	[− 0.16; 0.52]	0.289	3.04	0.38	0.17	[0.04; 0.72]	0.029	8.02
	Pregnancy depression	0.57	0.10	[0.37; 0.77]	< 0.001	26.31	0.50	0.10	[0.30; 0.70]	< 0.001	16.32
	Care type: MGP = 1, SC = 0	0.80	1.14	[− 1.47; 3.07]	0.485	1.32	0.83	1.11	[− 1.38; 3.04]	0.458	1.24
	Objective hardship	0.08	0.04	[0.01; 0.16]	0.021	0.96	0.003	0.03	[− 0.06; 0.06]	0.933	0.04
	Objective hardship X Care type	− 0.11	0.05	[− 0.21; − 0.01]	0.031	3.25	0.01	0.05	[− 0.08; 0.10]	0.855	0.02
Model 2	Socioeconomic status	0.01	0.01	[− 0.01; 0.02]	0.205	1.80	0.01	0.01	[− 0.004; 0.02]	0.153	1.61
	Stressful life events in pregnancy	0.17	0.17	[− 0.17; 0.51]	0.326	2.96	0.39	0.17	[0.05; 0.72]	0.025	7.91
	Pregnancy depression	0.52	0.11	[0.31; 0.74]	< 0.001	26.63	0.50	0.10	[0.30; 0.71]	< 0.001	16.72
	Care type: MGP = 1, SC = 0	− 2.46	1.31	[− 5.06; 0.14]	0.064	1.03	2.16	1.29	[− 0.39; 4.72]	0.097	1.67
	Objective hardship	0.01	0.03	[− 0.06; 0.07]	0.816	0.57	− 0.01	0.03	[− 0.06; 0.04]	0.689	0.03
	Cognitive appraisal: neutral and positive vs. negative	− 2.25	1.23	[− 4.68; 0.19]	0.07	1.04	0.12	1.12	[− 2.11; 2.35]	0.913	0.15
	Cognitive appraisal X Care type	2.23	1.58	[− 0.91; 5.37]	0.162	1.38	− 1.39	1.54	[− 4.44; 1.67]	0.37	0.53
Model 3	Socioeconomic status	0.01	0.01	[− 0.001; 0.02]	0.079	1.09	0.01	0.01	[− 0.004; 0.02]	0.194	0.72
	Stressful life events in pregnancy	0.10	0.16	[− 0.22; 0.42]	0.542	3.04	0.31	0.16	[− 0.02; 0.63]	0.065	8.02
	Pregnancy depression	0.52	0.10	[0.33; 0.71]	< 0.001	26.31	0.45	0.10	[0.26; 0.64]	< 0.001	16.32
	Care type: MGP = 1, SC = 0	− 1.22	0.71	[− 2.63; 0.19]	0.089	1.32	0.80	0.69	[− 0.57; 2.16]	0.248	1.24
	Objective hardship	− 0.02	0.03	[− 0.08; 0.05]	0.594	0.96	− 0.05	0.03	[− 0.11; 0.01]	0.073	0.04
	Subjective stress	2.44	0.63	[1.19; 3.69]	< 0.001	4.70	1.99	0.60	[0.80; 3.17]	0.001	6.99
	Subjective stress X Care type	− 2.19	0.77	[− 3.72; − 0.66]	0.006	4.95	− 0.72	0.73	[− 2.17; 0.73]	0.329	0.58

[a] 95% confidence interval around the point estimate (unstandardized coefficient); significant if it does not cross 0

[b] The Variance explained column presents the amount of additional variance explained by each variable, as it was originally entered into the equation hierarchically

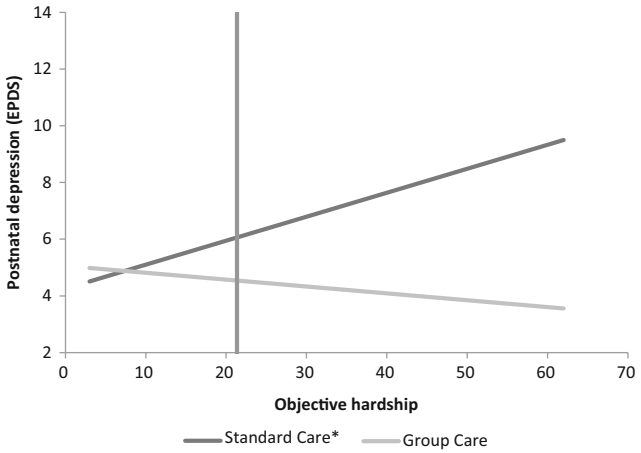

Fig. 1 Interaction effect (p = .031) between care type (48 MGP, 54 SC) and objective hardship on postnatal maternal depression score at 6 weeks (*p < 0.05 for SC group). The vertical line indicates the hardship level above which significant between group differences are found

such that higher stress was associated with more depressive symptoms, but no significant care type interaction after controlling for other variables. The final model explained 33.9% of the variance in depression at 6 months.

Maternal anxiety Table 3 shows the results from the six multivariable hierarchical linear models for the postnatal maternal anxiety scores at 6 weeks and 6 months. Similar to the postnatal depression results, there was a significant main effect of depression at hospital registration on anxiety levels, explaining approximately 33% of unique variance at 6 weeks, and approximately 18% at 6 months.

Objective hardship, subjective stress, and cognitive appraisal At 6 weeks postpartum, there was a significant buffering against subjective stress (p = 0.048). Specifically, MGP women's anxiety scores were not affected by subjective stress, whereas SC women's anxiety scores were significantly affected: the higher the subjective stress from the flood, the higher the anxiety scores at 6 weeks (shown in Fig. 3). Although the groups did not differ in anxiety when subjective stress was low, the SC group had significantly more severe symptoms than the MGP group when subjective stress was greater than 0.732 (0.73 of 1 SD). There were no significant main effect or interaction results involving maternal cognitive appraisal at 6 weeks. The objective hardship model explained a total of 42.6% of the variance in 6-week anxiety scores, the cognitive appraisal model explained 41.9%, and the subjective distress model explained 45.3%.

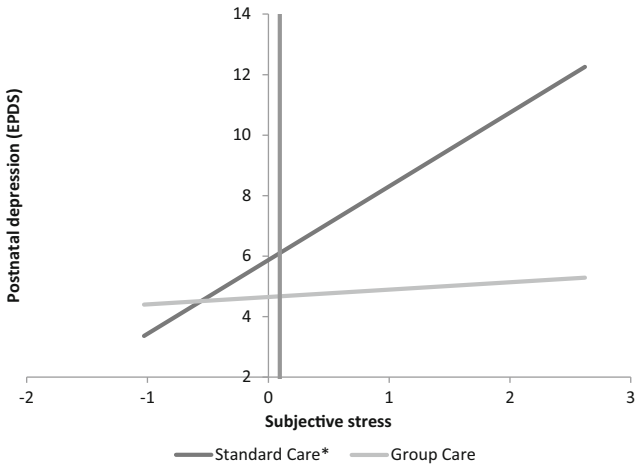

Fig. 2 Interaction effect (p = .006) between care type (48 MGP, 54 SC) and subjective distress on postnatal maternal depression score at 6 weeks (*p < 0.05 for SC group). The vertical line indicates the distress level above which significant between group differences are found

At 6 months postpartum, neither objective hardship, subjective stress, nor cognitive appraisal explained significant amounts of variance in anxiety. None of the interactions with care type were significant. The three models explained 30.4, 31.5, and 30.9% of the variance in 6-month anxiety scores, respectively, primarily as a function of significant effects of pregnancy depression and other life events in pregnancy.

It is noteworthy that among the several potential predictors included in the regression models other than flood variables and care type, EPDS at hospital registration was the only variable that significantly predicted postnatal depression and anxiety at both 6 weeks and 6 months. Over and above the variance already explained by other variables in the model, pregnancy depression explained approximately 26 and 16% of the variance of postnatal maternal depression at 6 weeks and 6 months, respectively. In postnatal maternal anxiety, pregnancy depression explained about 33 and 19% of the variance in the outcome assessed at 6 weeks and 6 months, respectively. Stressful life events predicted greater levels of both depression and anxiety at 6 months only, explaining 8–9% of the variance, in all but one of the models (Table 2 model 3: depression and subjective stress (p = 0.07)).

Discussion

As predicted and as shown in previous research, this study demonstrates that a higher EPDS score at hospital registration in pregnancy, and a greater number of stressful life events a woman has experienced, predict more severe postpartum anxiety and depression. In addition however, the 6-week postpartum depression and anxiety of women who had been in standard care was a function of the severity of the objective exposure to the flood and their level of subjective distress; on the other hand, the women in the MGP (continuity) group appeared to be protected to some degree from both the objective and subjective aspects of their flood experiences. For those women who had higher levels of objective or subjective stress, the SC model of midwifery care was associated with significantly more severe depression and anxiety scores at 6 weeks

Table 3 Three multivariable linear models for predicting postnatal maternal anxiety score at 6 weeks and 6 months, for (1) objective hardship, (2) cognitive appraisal, and (3) subjective stress

	Predictors	6 weeks (48 MGP, 54 SC)					6 months (65 MGP, 53 SC)				
		Regression coefficient				Variance explained (%)[b]	Regression coefficient				Variance explained (%)[b]
		Point estimate	Standard error	95% CI[a]	*p* value		Point estimate	Standard error	95% CI[a]	*p* value	
Model 1	Socioeconomic status	0.01	0.01	[− 0.02; 0.03]	0.652	0.23	0.01	0.01	[− 0.01; 0.04]	0.289	0.96
	Stressful life events in pregnancy	0.12	0.33	[− 0.54; 0.78]	0.717	2.99	0.86	0.34	[0.18; 1.53]	0.013	9.34
	Pregnancy depression	1.32	0.20	[0.93; 1.71]	< 0.001	32.72	1.08	0.20	[0.68; 1.47]	< 0.001	18.40
	Care type: MGP = 1, SC = 0	1.89	2.25	[− 2.58; 6.36]	0.403	0.30	2.83	2.20	[− 1.52; 7.18]	0.201	1.53
	Objective hardship	0.23	0.07	[0.09; 0.37]	0.002	4.21	0.03	0.06	[− 0.09; 0.14]	0.622	0.08
	Objective hardship X Care type	− 0.18	0.10	[− 0.38; 0.01]	0.062	2.15	− 0.03	0.09	[− 0.21; 0.15]	0.719	0.08
Model 2	Socioeconomic status	0.00	0.01	[− 0.02; 0.03]	0.744	0.39	0.02	0.01	[− 0.01; 0.05]	0.131	1.51
	Stressful life events in pregnancy	0.08	0.34	[− 0.60; 0.75]	0.824	2.95	0.87	0.34	[0.20; 1.54]	0.012	9.23
	Pregnancy depression	1.32	0.21	[0.90; 1.74]	< 0.001	32.86	1.12	0.21	[0.71; 1.53]	< 0.001	18.60
	Care type: MGP = 1, SC = 0	− 4.61	2.59	[− 9.76; 0.54]	0.079	0.23	1.43	2.58	[− 3.68; 6.53]	0.58	1.85
	Objective hardship	0.15	0.06	[0.02; 0.27]	0.021	3.96	0.01	0.05	[− 0.09; 0.12]	0.817	0.00
	Cognitive appraisal: neutral and positive vs. negative	− 1.78	2.43	[− 6.60; 3.04]	0.465	0.05	0.32	2.25	[− 4.13; 4.77]	0.886	0.14
	Cognitive appraisal X Care type	4.81	3.13	[− 1.40; 11.01]	0.127	1.48	1.34	3.08	[− 4.76; 7.44]	0.665	0.12
Model 3	Socioeconomic status	0.01	0.01	[− 0.02; 0.03]	0.447	0.23	0.02	0.01	[− 0.01; 0.04]	0.221	0.96
	Stressful life events in pregnancy	− 0.01	0.33	[− 0.66; 0.65]	0.984	2.99	0.78	0.34	[0.11; 1.45]	0.024	9.34
	Pregnancy depression	1.25	0.20	[0.86; 1.64]	< 0.001	32.72	1.05	0.20	[0.65; 1.44]	< 0.001	18.40
	Care type: MGP = 1, SC = 0	− 1.50	1.44	[− 4.36; 1.36]	0.302	0.30	2.07	1.42	[− 0.75; 4.88]	0.148	1.53
	Objective hardship	0.06	0.07	[− 0.07; 0.19]	0.336	4.21	− 0.03	0.06	[− 0.14; 0.09]	0.641	0.08
	Subjective stress	3.62	1.28	[1.08; 6.16]	0.006	2.50	1.95	1.23	[− 0.49; 4.39]	0.116	0.98
	Subjective stress X Care type	− 3.14	1.57	[− 6.25; − 0.03]	0.048	2.34	− 1.45	1.51	[− 4.44; 1.54]	0.338	0.57

[a] 95% confidence interval around the point estimate (unstandardized coefficient); significant if it does not cross 0

[b] The Variance explained column presents the amount of additional variance explained by each variable, as it was originally entered into the equation hierarchically

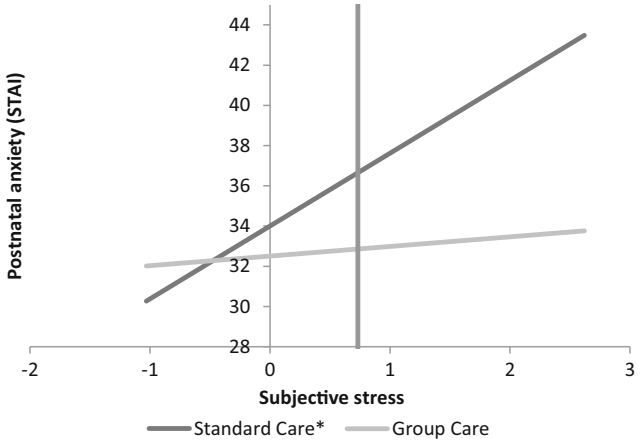

Fig. 3 Interaction effect ($p = .048$) between care type (48 MGP, 54 SC) and subjective distress on postnatal maternal anxiety score at 6 weeks (*$p < 0.05$ for SC group). The vertical line indicates the distress level above which significant between group difference are found

postpartum compared to women who received MGP (continuity) care who seemed generally unaffected by the flood stress. Randomised trials have shown the benefits of MGP care to include a more positive birth experience (Forster et al. 2016), reduced interventions in birth (less amniotomy, regional analgesia, episiotomy, and instrumental births) and better birthing (spontaneous vaginal birth) and infant outcomes (reduced preterm birth and less foetal loss before and after 24 weeks plus neonatal death) (Sandall et al. 2016). In the largest trial of MGP internationally, women receiving MGP care were three times more satisfied than women in SC and more likely to report that they were given the advice they needed with breastfeeding, handling, settling, and caring for the baby, and about their own health and recovery after the birth (Forster et al. 2016). The current study shows that for women impacted by a natural disaster, MGP care buffers the effect of greater objective flood-related hardship and subjective distress on both depression and on anxiety scores up to 6 weeks postnatally for subjective stress. At 6 weeks postpartum, there is a trend for MGP mothers to have lower depression levels than SC ($p = 0.10$), while at 6 months postpartum, the MGP group has slightly higher depression scores although there are no significant differences between the two treatment groups.

One key difference between the models of care is the way postpartum support is provided. In the MGP group, this is often determined by the woman herself, in consultation with her midwife and according to need with the model able to offer support up until 6 weeks postpartum. Women in MGP received significantly more visits than women in SC, and this may be one of the reasons the MGP care model buffers the impact of the flood on women's postnatal mental health. Despite the increased number of visits, it is important to note that the larger RCT, with more than 1700 women enrolled in Brisbane and Sydney, comparing the clinical and cost outcomes of the MGP model of care to standard care found that not only was MGP care safe, but it cost significantly less (Tracy et al. 2013).

Our findings are similar to those from a perinatal support program called *Healthy Start*, which buffered pregnant women's wellbeing in the post-Hurricane Katrina disaster recovery period (Giarratano et al. 2015). While these findings were limited to young, poor, and less-educated mothers who had been severely impacted by the hurricane, they reported similar birth outcomes to the less at-risk population accessing standard care, suggesting a positive influence of the broader, personalised support that included home visits, case management, health education, assistance with social support, and other services. Similarly, the Nurse-Family partnership (NFP) studies, with low SES first-time mothers, showed that in-home visits from a nominated nurse home visitor during pregnancy and postpartum had beneficial effects on postnatal maternal life course with fewer subsequent pregnancies, greater participation in the workforce, and less reliance on social welfare (Olds 2006). Like the MGP program, the NFP has a high component of relational continuity between the woman and her care provider (nurse in NFP), which is likely to be a key component of positive maternal outcomes in both programs.

The continuity of care provided by the MGP model provides more personalised care than the SC model, with 24/7 phone access to a known midwife from booking in antenatally up until discharge from the program, group sessions for women aimed at increasing maternal and infant health literacy, peer support, and individualised case management through pregnancy, and birth and the early postpartum period. One key factor thought to be impacting outcomes is the therapeutic relationship that develops between the woman and her primary midwife (Sandall et al. 2016) that results in increased advocacy, empathic care (Walsh and Devane 2012), and engagement in health services (Allen et al. 2016). Recipients of MGP care report a more positive birth experience, with more control in labour and less anxiety than women in standard care (McLachlan et al. 2016). The flexibility of the model allows a more personalised and flexible approach both motivating and enabling midwives to go above and beyond what they are able to do in SC where the absence of continuity of carer and lack of time can see midwives focussing on the biomedical aspects of care while ignoring the psycho-social-emotional dimensions (Allen et al. 2017). In Australia, as a result of the M@NGO trial, the MGP model is being expanded to women who have identified risks or vulnerabilities in pregnancy with MGP teams being established and modified for Aboriginal and Torres Strait Islander women (Kildea et al. 2016, 2017), young women (Allen et al. 2016), and women from a refugee background. Whether the results seen following this sudden-onset stressor will translate to a vulnerable population with significant life stressors in pregnancy is currently being investigated in at least one study (Kildea et al.

2017). The benefits of MGP were present to 6 weeks postpartum, which is the length time for which women can receive care under this program. However, the benefits did not extend to 6 months, particularly for levels of depression, at which time women were no longer receiving MGP care, suggesting the benefits may be limited to current care status only. However, it must be noted that the MGP model was not designed to counteract the long-term effects of traumatic events such as flooding which these women experienced during their pregnancy.

The role of the GP, Child and Family Health Nurse (CFHN), and other health providers who may offer support or specialised care is largely unexplored in this study and merit further research. Other Australian work has shown the transition from maternity care to child and family health services is less than ideal particularly regarding communication and handover of information (Homer et al. 2009). The GP will often have an ongoing relationship with a woman and her family while she receives pregnancy care from additional providers, while CFHNs are available from birth to 5 years. Given these are universal services in Australia with a broad reach, increasing support and strengthening communication between standard hospital care providers, GPs and CFHNs, particularly for women at risk, may provide opportunities for increased relation-based support and involvement when a natural disaster has occurred. Improved transfer of care from MGP to GPs and CFHNs at the 6-week handover may also assist to buffer the impact of the stress for longer periods. At the 6-month time point, the factors that continued to be associated with high levels of depression and anxiety were the number of non-flood life events in pregnancy and antenatal EPDS scores, which underlies the importance of screening and referral to specialised services, for example psychologists and perinatal mental health specialists. Potentially extending MGP or other support services further into the postpartum period for selected women might also produce more enduring, longer-term benefits for maternal mental health.

Both the objective severity of the hardship endured by the women from the flood and their emotional reactions (subjective stress) were predictive of postnatal depression at 6 weeks and 6 months even when controlling for depression in pregnancy; interestingly, whether the women considered that the effects of the flood were positive, neutral, or negative (cognitive appraisal) appeared to have no effect on postnatal anxiety or depression. However, depression scores during pregnancy were consistently the most predictive variable of postnatal mental health at 6 weeks (which explained 26–33% of the variance) and at 6 months (16–18% of variance). As has been previously documented (Ward et al. 2016), the number of stressful life events in pregnancy, other than the disaster, was predictive of postnatal mental wellbeing.

Women's postnatal wellbeing has particularly important consequences for child development: children of women who experience postnatal depression or anxiety show increased rates of poor physical health, attachment disorders, and developmental psychopathology (Glasheen et al. 2010; Goodman and Gotlib 1999; Stein et al. 2014). Similar negative developmental outcomes are also associated with PNMS, with research showing that exposure to life-event stressors or natural disasters predict poorer birth outcomes, developmental delays, and behavioural problems (Talge et al. 2007). Therefore, the current finding that continuity of care protects women who are pregnant during a disaster by buffering her early postnatal mental wellbeing may also contribute additional indirect benefits to her child's development.

The current study has several limitations. First, the women enrolled in the M@NGO trial were randomly assigned to MGP or SC and may have differed from the QF2011 women who self-selected their care type, or were allocated by the hospital staff, depending on spaces available in the MGP or other models. Indeed, we were unable to test this model in the randomised group due to uneven distribution between the groups. Allocation to model of care occurred prior to enrolment in the QF2011 study thus women were unable to be randomised, and self-selection into the model may have introduced a bias that was not detectable. No significant differences between the groups were found in the study variables; however, there may have been some (unidentified) reason that women differed between groups, or for women selecting a particular model of care in the QF2011 subsample. The flood status would not have been known at the time of allocation to care model; thus, women would not have been directed towards this model of care due to presumed vulnerability by the allocation midwife. Additionally, we were unable to examine differences in partner and family support, which would have been valuable. Second, the final sample size was relatively small ($N = 126$) having been reduced due to missing data from 34 women, a common problem in longitudinal research. Nevertheless, there was sufficient power to detect significant group differences and interactions. Third, the sample of women was relatively homogenous, primarily Caucasian Australians of middle to upper socioeconomic status, therefore, potentially reducing the generalizability of the findings to the wider community. However, it is possible that the effects of a sudden-onset stressor like a natural disaster would more acutely affect other vulnerable populations who may not have the resources available to the current sample.

In summary, this is the first study to show that model of maternity care, MGP, mitigates the effects of higher levels of stress experienced by women up to 6 weeks postnatal in the context of a natural disaster. The longer-term impact of MGP care is not known; however, it may have indirect benefits for child development, which is closely linked with both PNMS and maternal postnatal wellbeing. Randomised trials have found that MGP care is a protective model of midwifery care, not only for women with no identified risk factors in

pregnancy (Forster et al. 2016; McLachlan et al. 2012, 2016) but also for women with identified risk in pregnancy (Tracy et al. 2013). These results reinforce that it is also a model of care that provides some protection in times of adversity. Further, research into which component of MGP care is providing this buffering is important and extending MGP care into the postpartum period from 6 weeks to 6 months for those experiencing, or at a higher risk of, depression (based on screening in pregnancy), may be of further benefit to mothers during this time. Alternatively, increasing relational continuity in maternal child health or other services that can be introduced before handover of care occurs, possibly in the antenatal period for women identified to be at risk, may also provide benefit. Utilising additional support from GPs, who may continue to see women throughout pregnancy and for many years afterward, often providing high levels of relational continuity, may also buffer high levels of stress from a natural disaster. Further research looking at these factors, or aiming to replicate our findings within a randomised trial would be valuable, particularly given that the world is seeing a steadily increasing number and severity of severe weather events.

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Compliance with ethical standards

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

Ethical approval Ethical approval was obtained from the Human Research Ethics Committees at the study site hospital and affiliated university (reference numbers 1709M and 2013001236, respectively).

Informed consent All participants provided written informed consent at recruitment into the study and when completing the 6-week and 6-month postnatal surveys.

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