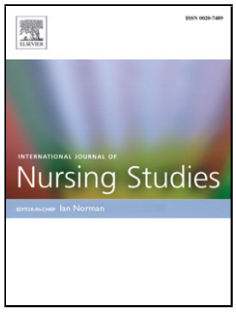

Title: Does model of maternity care make a difference to birth outcomes for young women? A retrospective cohort study

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Title Page

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Contribution of the Paper

What is already known about the topic?

- There is scant evidence to support the delivery of maternity care to young women through caseload midwifery or young women's clinic models of care.
- A 2013 Cochrane systematic review of midwife-led models of care (which included three trials of caseload midwifery) reported better perinatal outcomes for women and their babies; however the mean age of participants was 26-31 years across the trials. Results cannot therefore be generalised to young women.
- In 2013 we published a study that tested whether a RCT of caseload midwifery for adolescents was possible; we concluded it was not feasible.

What this paper adds

- Caseload midwifery, compared to standard care, may be associated with fewer preterm births and neonatal intensive care unit admissions for women aged 21 years or less.

Abstract and Key Words

Background	Adolescent pregnancy is associated with adverse outcomes including preterm birth, admission to the neonatal intensive care unit, low birth weight infants, and artificial feeding.
Objective	To determine if caseload midwifery or young women's clinic are associated with improved perinatal outcomes when compared to standard care.
Design	A retrospective cohort study.
Setting	A tertiary Australian hospital where routine maternity care is delivered alongside two community-based maternity care models specifically for young women aged 21 years or less: caseload midwifery (known midwife) and young women's clinic (rostered midwife).
Participants	All pregnant women aged 21 years or less, with a singleton pregnancy, who attended a minimum of two antenatal visits, and who birthed a baby (without congenital abnormality) at the study hospital during May 2008 - December 2012.
Methods	Caseload midwifery and young women's clinic were each compared to standard maternity care, but not with each other, for four primary outcomes: preterm birth (<37 weeks gestation), low birth weight infants (<2500g), neonatal intensive care unit admission, and breastfeeding initiation.

	Two analyses were performed on the primary outcomes to examine potential associations between maternity care type and perinatal outcomes: intention-to-treat (model of care at booking) and treatment-received (model of care on admission for labour / birth).
Results	1908 births were analysed by intention-to-treat and treatment-received analyses. Young women allocated to caseload care at booking, compared to standard care, were less likely to have a preterm birth (adjusted Odds Ratio (aOR) 0.59 (0.38-0.90, p=0.014) or a neonatal intensive care unit admission aOR 0.42 (0.22-0.82, p=0.010). Rates of low birth weight infants and breastfeeding initiation were similar between caseload and standard care participants. Participants allocated to young women's clinic at booking, compared to standard care, were less likely to have a low birth weight infant aOR 0.49 (0.24-1.00, p=0.049), however when analysed by treatment-received, this finding was not significant. There was no difference in the other primary outcomes.
Conclusions	Young women who were allocated to caseload midwifery at booking, and/or were receiving caseload midwifery at the time of admission for birth, were less likely to experience preterm

	birth and neonatal intensive care unit admission.

Key words: Adolescent Pregnancy, Antenatal Care, Cohort Study, Perinatal Outcomes, Maternity Care, Midwifery.

Introduction

This cohort study is part of mixed methods evaluation of two models of maternity care that were designed for, and delivered to, young women aged 21 years or less. The participants in this study have been termed 'young women'. Young adulthood includes the period from 20-24 years of age (World Health Organisation, 2004), whereas adolescence is typically defined as the period from 10-19 years of age (World Health Organisation, 2014). Research literature on adolescent pregnancy is considered in this paper because it is the most closely related to the participants; however women aged 20-21 years may not have the same predictors for poor perinatal outcomes that adolescents have.

This study was set in a context where women have access to a number of different models of maternity care. A model of maternity care is a 'complex intervention'; it has a number of 'active ingredients' that work together in order to be effective (Medical Research Council, 2008). The ingredients which define a model of maternity care include: who provides the care (doctors, midwives, allied health), whether the providers are known to the woman, where the care occurs (at home, in hospital, community venue), when the care occurs (gestation at booking, frequency and length of visits, after hours contact), and how the care is provided (one-to-one or group visits). Two models of maternity care (caseload midwifery and young women's clinic) were defined and compared to routine care (standard care) for four primary outcomes.

Background

Pregnant adolescents are more likely to come from socio-economically disadvantaged backgrounds (Imamura et al., 2007), which is associated with smoking, alcohol and illicit drug use (van Gelder et al., 2010), social isolation and mental health issues (Ickovics et al., 2011), poor nutrition and inadequate weight gain (Kabir, Sheeder, & Stevens-Simon, 2008), and psychosocial stressors including low income, unemployment and housing issues (Savitz et al., 2004). These factors directly affect perinatal outcomes (Malabarey, Balayla, Klam, Shrim, & Abenhaim, 2012). Maternal age less than 18 years is an independent risk factor for preterm birth (Khashan, Baker, & Kenny, 2010), low birth weight (LBW) infants (de Vienne, Creveuil, & Dreyfus, 2009), intrauterine growth restriction and stillbirth (Khashan, et al., 2010), and neonatal mortality (de Vienne, et al., 2009).

Modifying the risk and protective factors in young women's daily lives, particularly for those who are socio-economically disadvantaged, can improve health outcomes (Viner et al., 2012). Young women attend specialist programs more frequently than standard antenatal care (Allen, Gamble, Stapleton, & Kildea, 2012); attendance increases the opportunities for health interventions to occur. There is increasing evidence that 'adequate' antenatal care (e.g. minimum five visits) can improve perinatal outcomes (Raatikainen, Heiskanen, Verkasalo, & Heinonen, 2005; Vieira et al., 2012). The different types of maternity care referenced in the literature are defined and described below.

Standard care

Maternity care in Western countries including Australia, Canada, New Zealand (NZ), the United Kingdom (UK) and the United States (US) is typically provided through one-to-one visits with a doctor or midwife. In Canada and the US over 90% of antenatal care is provided by doctors, compared with NZ and the UK where care is generally provided by midwives and is government-funded (public) (Ehiri & Child, 2009). The majority (70%) of Australian women access public maternity care which is provided by hospital-based midwives or obstetricians, and to a lesser extent community-based family physicians; 30% of women access private obstetric care (Department of Health and Ageing, 2008). Ninety-seven percent of women give birth in a hospital delivery suite; while two percent access a birth centre and fewer than one percent give birth at home (Laws & Sullivan, 2009). Public maternity care is often fragmented, with women typically meeting numerous clinicians (Hartz, Foureur, & Tracy, 2012). This is slowly changing in Australia, and elsewhere, as more hospitals are reorganising services to optimise midwifery continuity of care (Hartz, et al., 2012).

Caseload midwifery

Caseload midwifery is increasingly common in countries including Australia, Canada, NZ and the UK (Hartz, et al., 2012). The primary purpose of caseload midwifery is relationship building whereby women feel supported by a “known, trusted midwife” throughout pregnancy, birth and the postpartum period (Sandall, Soltani, Gates, Shennan, & Devane, 2013). In Australia, caseload midwifery is characterised by a midwife undertaking responsibility for the continuum of care throughout pregnancy, birth and postpartum, for a caseload of approximately 40 women per annum in low or

all-risk models (Hartz, et al., 2012). Caseload midwives often work in a midwifery group practice (MGP) of four midwives, who are on-call for labour and birth; and then continue care up to six weeks following birth (Hartz, et al., 2012). A feature of the model is that women have 24-hour telephone access to their primary or back-up midwife (Forti, Stapleton, & Kildea, 2013).

A 2013 systematic review included 13 trials of midwife-led continuity models of care either team midwifery (n=10) or caseload midwifery (n=3); both models aimed to provide known midwives during pregnancy, birth and postpartum (Sandall, et al., 2013). While adolescent women were eligible to participate in the three trials of caseload midwifery (Sandall, et al., 2013); the mean age of participants ranged from 26-31 years. Therefore, the systematic review does not address the suitability and efficacy of caseload midwifery for young women. Access to caseload midwifery has been mostly limited to 'low risk' women; indeed two of the three caseload midwifery trials excluded participants deemed to have risk factors. A recently published randomised controlled trial (RCT) demonstrates that caseload midwifery is safe and cost-effective for women of 'all risk' (Tracy et al., 2013); participants in this trial however were aged 18 years or older.

In the research setting, group antenatal care was provided within the caseload model for young women; therefore group antenatal care research literature is briefly described here. A Cochrane systematic review of two RCTs of group antenatal care (CenteringPregnancy™) versus standard care reported no significant differences for key clinical outcomes including preterm birth (Homer et al. 2012). However, the

largest RCT (n=1047) reported that women who received the intervention (i.e. group antenatal care) were less likely to experience preterm birth and more likely to initiate breastfeeding (Ickovics 2007). The inclusion of group antenatal care in the caseload model is a potential limitation that will be explored further in this paper.

Young women's clinic

Young women's clinic describes an antenatal model of care that focuses exclusively on pregnant young women (Allen, et al., 2012). Key elements include a community clinic setting, multi-disciplinary involvement at the clinic, with midwives following additional clinical guidelines and accessing specialist training (e.g. sexual health, illicit drug use) (Allen, et al., 2012). Two cohort studies report an association between young women's clinic and fewer preterm births for adolescent women (Fleming, Tu, & Black, 2012; Quinlivan & Evans, 2004) and lower adjusted relative risk of LBW infants (Fleming, et al., 2012). There are three other published research papers assessing young women's clinic however the results are unreliable as they were small, underpowered retrospective cohort studies, with differences in baseline characteristics that were not controlled for in the analysis (Allen, et al., 2012).

Aim

There is a paucity of evidence evaluating the specific effects of models of maternity care on perinatal outcomes for young women. The aim of this study was to determine if caseload midwifery or young women's clinic were associated with improved perinatal outcomes when compared to standard care.

Methods

Study design

Ethical approval was granted by the University and Hospital Human Research Ethics Committees prior to study commencement. A retrospective comparative cohort study was designed using routinely collected perinatal data from the hospital's electronic database. Three mutually exclusive study groups: (1) standard care, (2) caseload midwifery and (3) young women's clinic were defined at first booking visit and on admission to hospital for labour/birth. The primary outcomes were then analysed by both intention-to-treat (model of care at booking) and treatment-received (model of care on admission for labour/birth). The secondary outcomes were analysed by treatment-received. Caseload midwifery and young women's clinic were each compared to standard care. Caseload midwifery and young women's clinic were not compared with each other. The model of care at the time of maternity booking was recorded electronically by the booking midwife. The model of care at the time of admission for labour / birth was recorded electronically by the intrapartum midwife after reviewing the woman's antenatal attendance record. If the model of care at the time of maternity booking was different to the model recorded at the time of admission for labour / birth, then the researcher reviewed the electronic appointment system to confirm the model of care received. The model of care received was defined as the one through which the woman accessed the majority of her antenatal care.

Setting

The site was an Australian tertiary-level, maternity hospital with around 5000 public births per year, where both hospital and community-based antenatal services are provided. Two midwifery-led services for young women operated at this site: young women's clinic began in 1994 and a caseload midwifery group exclusively for young women began in May 2008. Pregnant women aged 21 years or less are generally referred to caseload midwifery in the first instance. If caseload midwifery is full, women decline caseload midwifery, or women are unable to be contacted via telephone to arrange a home booking visit; then they are usually allocated to the young women's clinic. If spaces subsequently become available in caseload midwifery, young women's clinic attendees are invited to transfer to caseload care. After the first booking visit, women may 'opt out' of either of these programs and choose standard care if they prefer to see their family physician (GP), or another specialist service (e.g. Refugee women), do not like the way the care was provided, cannot easily access the community venue, or develop serious medical risk factors that required hospital-based care (e.g. access to medical physician).

Caseload care is provided by a group of four hospital-employed midwives who provide care to 'all risk' women aged ≤21 years with a reduced annual caseload of 35 women per midwife (see Table 1). The woman's primary midwife is available on-call five days per week; in the event the midwife is unavailable (e.g. day off or annual leave) the woman will be cared for by a back-up caseload midwife that she has previously met.

Young women's clinic is staffed by a small team of midwives who provide individual antenatal visits for women aged ≤21 years at the same aforementioned community venue (see Table 1). During labour and birth, young women will be seen in hospital by clinicians they have not previously met. Women may receive postnatal home visiting following birth by rostered midwives who they are unlikely to have met.

Standard care is defined as public maternity care offered by hospital clinicians or family physicians where the care was not organised to provide continuity of care and was not specific to young women (see Table 1). The former part of this definition of standard care was used by a 2013 Australian RCT of caseload midwifery compared to standard care (Tracy, et al., 2013).

Participants and study size

All women who gave birth at the study hospital during the study period, who were aged 21 years or less at the time of birth, were considered for inclusion (see Figure 1). Additional eligibility criteria were: singleton pregnancy, baby without a diagnosed congenital abnormality, attendance for at least two scheduled antenatal appointments, booked as a public patient. Exclusion criteria were: unbooked or attendance at fewer than two scheduled antenatal appointments, multiple birth, baby with a congenital abnormality, or in-utero transfer to the tertiary hospital (due to complications of pregnancy). The sample size was determined by the number of records available. All records from when caseload midwifery commenced births in May 2008 -December 2012 were considered for inclusion in the study; see Figure 1.

Crossovers between allocation (model at first booking visit) and allocation received (model on admission for labour/birth) are detailed in Figure 1.

Data Sources

Midwives prospectively enter standardised information into the electronic hospital perinatal database. Information is entered at the first booking appointment, and during any inpatient care episode including labour and birth. At the time of this study information was not entered during outpatient antenatal appointments. Medical chart audit was used to locate missing data for pre-pregnancy body mass index (BMI).

Routinely collected data were obtained from two obstetric databases (Obstetric Clinical Reporting System (Obstetric CRS), Clinical Reporting Systems Pty Ltd, New South Wales (NSW), Australia and MatriX, Meridian Health Informatics, NSW, Australia). Obstetric CRS is checked on a daily basis to identify potential data entry errors and incomplete records. If discrepancies are found, they are rectified within the system. MatriX has rules programmed into the system to alert the user as they are entering data to any entries that are inconsistent, missing, or appear erroneous, allowing the user to correct errors immediately. Data were extracted based on maternal age at birth (21 years or less), singleton pregnancy (yes), and baby's date of birth (May 2008 – December 2012). Once extracted from both databases, data were merged and imported into a statistical program for manipulation.

The first author identified participants in the dataset with missing pre-pregnancy BMI, then used their unique numeric identifiers to request and review patient charts to

obtain this information from the hand-written notes. The pre-pregnancy BMI field was then updated in the statistical program.

Variables

Demographic characteristics included maternal age (years), adolescent multiparity (aged 19 years or less when giving birth to a subsequent baby), nulliparity, ethnicity, socio-economic status (Socio-Economic Indexes for Areas [SEIFA] quintile (Australian Bureau of Statistics, 2008)), relationship status, smoking during pregnancy (at first booking appointment), history of illicit drug use, pre-pregnancy BMI, history of sexually transmitted infection (STI), history of mental illness, psychology referral offered and accepted, history of family involvement with the Department of Child Safety, social work referral offered and accepted, medical / obstetric risk factors (composite); see Table 2.

Two medical / obstetric risk variables were generated: risk at booking and risk at birth. These variables were determined by literature review and limited by the data items that were routinely collected. Risk factors at hospital booking included cardiac disease, endocrine disease, hypertension, diabetes, and hepatitis; multiple pregnancies and fetal anomalies were excluded. Risk at birth included (a) any medical indication for induction of labour or planned caesarean section (i.e. abnormal fetal welfare studies, antepartum haemorrhage, cardiac disease, cerebro-vascular disease, cholestasis, chorioamnionitis, diabetes (all types), fetal anomaly, fetal death, fetal growth disturbance, fetal growth restriction, hypertension (all types), isoimmunisation, maternal medica/surgical indication (unspecified), non-reassuring

fetal status and/or (b) any antenatal hospital admission to an inpatient ward. For the multivariate logistic regression a dichotomous variable was created: medical/obstetric risk identified at booking and/or birth (yes/no).

Four primary outcome measures were defined a priori: preterm birth (<37 weeks gestation), LBW infant (<2500g), admission at birth to a NICU (yes/no), and breastfeeding initiation. Breastfeeding was defined dichotomously as either exclusively breastfeeding (including expressed breast milk) or not exclusively breastfeeding (including artificial feeding or a combination of artificial and breastfeeding). The combined results of the intention-to-treat and treatment-received analyses are presented in Table 3.

Potential confounders were identified through review of the research literature. Confounders which demonstrated a significant effect on the primary outcome through bivariate analysis were included in the logistic regression modelling: admission to a neonatal nursery, antenatal attendance at fewer than five antenatal visits, birth weight, BMI, caesarean birth, ethnicity, LBW, marital status, maternal age, medical and/or obstetric risk, mode of birth, nulliparity, opioids / regional analgesia in labour, preterm birth, smoking at booking and socio-economic status.

Other outcome measures listed in the Cochrane systematic review of midwife-led continuity models of care (Sandall, et al., 2013) for which routinely collected data were available, have been reported as secondary outcomes. These include: antenatal attendance (fewer than five visits), antenatal hospitalisation, induction of labour, amniotomy, oxytocin augmentation during labour, opiate analgesia in labour,

regional analgesia in labour (epidural/spinal), mode of birth (spontaneous vaginal, instrumental vaginal, caesarean section) (Table 4).

Secondary neonatal outcomes were gestational age at birth, weight at birth, stillbirth, Apgar score less than seven at five minutes, breastfeeding on hospital discharge, small-for-gestational age (SGA; <10th centile using customised birth weight centiles) (Gibbons et al., 2013), and admission to a neonatal nursery (Table 4).

Statistical Methods

Analyses were undertaken in StataSE version 10 (StataCorp Pty Ltd, College Station, Texas). Bivariate analysis to compare variables between the three study groups was performed using chi-square tests for categorical data. The continuous data were not normally distributed so Kruskal-Wallis tests were performed, followed by Wilcoxon rank sum tests to compare caseload midwifery to standard care, and young women's clinic to standard care; probability value (p value) adjusted to 0.025.

Multivariate logistic regression was performed on the primary outcomes to calculate adjusted odds ratios (aORs) and associated 95% confidence intervals (CIs); p values less than 0.05 were considered statistically significant. Only those participants with no relevant missing data, for confounding variables, were included in the bivariate and multivariate analyses of primary outcomes. Two analyses were conducted on the primary outcomes: intention-to-treat (model of care at booking) and treatment received (model of care on admission for labour / birth). Bivariate logistic regression was used to determine the effect of confounders on the primary outcomes; potential

confounders with p values less than 0.1 were included in the multivariate logistic regression. Table 4 footnotes indicate which confounders were used in the multivariate regression for each primary outcome.

Results

Participants

All publicly-funded young women (aged 21 years or less) who had given birth to a singleton baby between May 2008 and December 2012 (n=2214) were considered for inclusion. 1971 women met the inclusion criteria and 243 women were excluded; complete data were available for 1908 participants (see Figure 1).

Descriptive data

Table 2 shows the baseline characteristics of the participant groups with caseload midwifery and young women's clinic providing care to a significantly higher proportion of women who were younger, nulliparous, Caucasian, living in areas of the highest advantage, with a higher incidence of mental health issues, a history of illicit drug use, and a lower incidence of medical/obstetric risk factors. The standard care cohort had a significantly higher proportion of older young women, teenage multiparas, women who were non-Caucasian, who lived in areas of the greatest disadvantage, with medical / obstetric risk factors. There was no significant difference between the three groups on measures of smoking at booking, pre-pregnancy BMI, or history of STI.

Main results

After adjustment for potential confounders the chances of preterm birth and admission to NICU were significantly lower for women allocated, and exposed, to caseload midwifery (Table 3), compared to standard care. Allocation to young women's clinic was weakly associated with fewer LBW babies; however when analysing women who actually received young women's clinic care this association became non-significant (Table 3). Neither caseload midwifery nor young women's clinic were associated with differences in the odds of initiating breastfeeding, when compared to standard care (Table 3). A sensitivity analysis was performed to assess whether the higher proportion of Indigenous young women in standard care, compared to caseload care, was associated with the significant differences found. Sensitivity analysis did not change the findings which remained significant.

The secondary outcomes (Table 4) were analysed by the model of care women were accessing at the time of admission for labour/birth. Baseline characteristic differences between the groups were not controlled for during analysis of secondary outcomes.

Discussion

Key Results

This cohort study suggests that, compared to standard care, caseload midwifery may benefit young women and their infants. While we showed no differences between young women's clinic and standard care on any of the primary outcomes; the ability

to detect differences was limited by the relatively small number of women in this cohort. After controlling for differences in baseline characteristics and known confounders, caseload midwifery was associated with fewer preterm births and fewer admissions to NICU by both intention-to-treat and treatment-received analyses.

Strengths and Limitations

Participants were routinely assigned to a model of maternity care by hospital staff with the choice to opt out after the first booking visit. This choice may have been influenced by age, ethnicity, parity, socio-economic status or medical risk factors. Indeed there were significant differences in the baseline characteristics of the participant groups i.e. maternal age, nulliparity, ethnicity, socio-economic status and medical / obstetric risk status. To address this potential source of bias we included these variables as confounders and controlled for them in the statistical analysis for primary outcomes. Furthermore, a strength of this study is that data were analysed both by intention-to-treat, and by treatment-received. So while participant choice and baseline characteristics may have influenced which model of care they ultimately received (treatment received analysis); these factors had limited power over the model of maternity care they were first allocated (intention-to-treat analysis).

The caseload model in this setting provided a one-on-one booking visit with a midwife (usually in the home) with all subsequent antenatal care delivered in groups. A RCT of group antenatal care, compared to standard care, for young women (aged 14-25 years) found a significantly lower incidence of preterm birth for those randomised to the intervention (Ickovics et al., 2007). Therefore, the inclusion of

group antenatal care in the caseload model in this setting is a potential confounding factor that may have positively affected preterm birth rates for young women in the caseload cohort.

No power calculation was performed on primary outcomes. An Australian cohort study, which included a larger number of participants in young women's clinic (n=541), reported a significant reduction in preterm birth (OR 0.40 p<0.001) although the analysis did not control for known confounders (Quinlivan & Evans, 2004). In the intention-to-treat analysis, the young women's clinic cohort was much larger (n=394) than in the treatment-received analysis (n=298). It is possible that the reduction in the number of participants is responsible for the shift from a significant to a non-significant difference on the outcome of LBW infants. The sample size for young women's clinic may therefore simply be too small to make robust conclusions about efficacy.

Interpretation

Preterm birth has very few known preventative interventions and many efforts to modify or eliminate specific risk factors have not succeeded to date (Lang & Lams, 2009). Pregnancy in adolescence is a risk factor for preterm birth (Chen et al., 2007; Khashan, et al., 2010; Shrim et al., 2011). The Cochrane systematic review finds women randomised to midwife-led continuity of care, compared to standard care, are less likely to give birth preterm (Sandall, et al., 2013). Our study is the first to report similar findings specific to young women; albeit not randomised.

Caseload midwifery is a safe and cost-effective maternity care intervention for women of all-risk (Tracy, et al., 2013). Higher levels of satisfaction are generally reported in models providing a known carer (Novick, 2009; Sandall, et al., 2013); adolescents are no exception (Payne & Smythe, 2007). Women who received caseload care had continuity of antenatal carer and telephone access to their midwife, or a known back-up midwife, 24 hours a day. The 'midwife-woman partnership' (Guilliland & Pairman, 1995) encourages women to engage in antenatal care: (i) to attend appointments (Raatikainen, et al., 2005), (ii) to disclose risk factors (Stanley, Borthwick, & Macleod, 2006) and (iii) to follow professional recommendations (Sheppard, Zambrana, & O'Malley, 2004). We hypothesise that antenatal engagement is the mechanism by which the complex intervention of caseload midwifery may affect perinatal outcomes for young women and their babies.

In this study, young women who received caseload midwifery were more likely to attend five or more antenatal visits compared to those in standard care. Adolescent attendance is more likely in the event of a good relationship with a care provider (Novick, 2009); 'vulnerable' women are less likely to attend when they perceive that clinicians treat them disrespectfully (Milligan et al., 2002). Attendance at five or more antenatal visits is associated with improved birth outcomes (Raatikainen, Heiskanen, & Heinone, 2007); it increases opportunities to screen for conditions that are amenable to intervention (e.g. genito-urinary infection). Further, adolescents who know and trust their care provider may be more likely to disclose harmful behaviours and difficult life circumstances (Sheppard, et al., 2004). A significantly higher

proportion of young women in caseload midwifery reported illicit drug use, mental health issues and Department of Child Safety involvement. Because pregnant women are more likely to disclose mental health concerns in the context of continuity of care with an accepting health professional (Stanley, et al., 2006); this finding may reflect increased disclosure rather than an increased incidence. This is significant because disclosure of risk factors confers opportunities for intervention. Indeed, young women receiving caseload midwifery were more likely to be offered, and to accept, psychology and social work referral.

While we have demonstrated a reduced likelihood of NICU admission under caseload care, this may be an artefact of fewer preterm births. Of the 98 admissions to NICU, 57 admissions (58%) were associated with complications of prematurity. Preterm birth and associated conditions (LBW, respiratory distress, poor feeding and/or hypoglycaemia) frequently lead to NICU admission (Celik, Demirel, Canpolat, & Dilmen, 2013). The resultant separation between young mothers and their babies has negative implications for maternal well-being (Lasiuk, Comeau, & Newburn-Cook, 2013) and breastfeeding (Parker et al., 2013). Admission to NICU is associated with significantly increased direct health care costs (Gilbert, Nesbitt, & Danielsen, 2003). Reduced preterm birth and subsequent NICU admission could improve maternal well-being and breastfeeding initiation; while delivering substantial health care savings.

Some maternal behaviours and stressors common to pregnancy in adolescence are independently associated with preterm birth. We hypothesise that caseload

midwifery may be able to address these modifiable risk factors by enhancing antenatal engagement. Young women's clinic showed promising results; further research that is statistically powered to assess its' efficacy is warranted. We recommend caseload midwifery, with obstetric and allied health support, be offered more widely to young women within a research evaluation framework.

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Figure 1

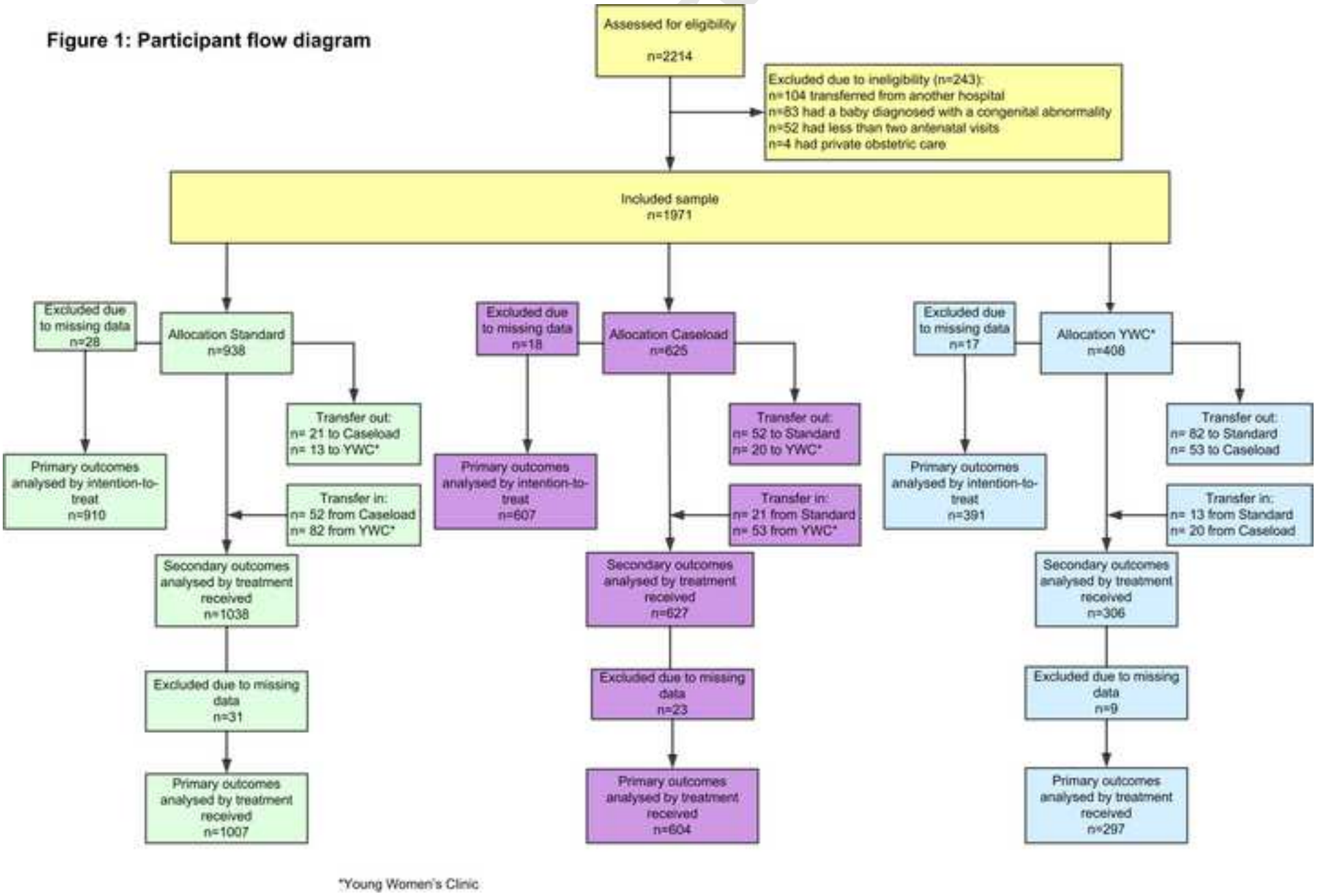
Figure 1: Participant flow diagram
Assessed for eligibility
n=2214
Excluded due to ineligibility (n=243):
n=104 transferred from another hospital
n=83 had a baby diagnosed with a congenital abnormality
n=52 had less than two antenatal visits
n=4 had private obstetric care
Included sample
n=1971
Excluded due to missing data
n=28
Allocation Standard
n=938
Transfer out:
n= 21 to Caseload
n= 13 to YWC*
Primary outcomes analysed by intention-to-treat
n=910
Transfer in:
n= 52 from Caseload
n= 82 from YWC*
Secondary outcomes analysed by treatment received
n=1038
Excluded due to missing data
n=31
Primary outcomes analysed by treatment received
n=1007
Excluded due to missing data
n=18
Allocation Caseload
n=625
Transfer out:
n= 52 to Standard
n= 20 to YWC*
Primary outcomes analysed by intention-to-treat
n=607
Transfer in:
n= 21 from Standard
n= 53 from YWC*
Secondary outcomes analysed by treatment received
n=627
Excluded due to missing data
n=23
Primary outcomes analysed by treatment received
n=604
Excluded due to missing data
n=17
Allocation YWC*
n=408
Transfer out:
n= 82 to Standard
n= 53 to Caseload
Primary outcomes analysed by intention-to-treat
n=391
Transfer in:
n= 13 from Standard
n= 20 from Caseload
Secondary outcomes analysed by treatment received
n=306
Excluded due to missing data
n=9
Primary outcomes analysed by treatment received
n=297
*Young Women's Clinic

Table 1 Differences between exposure groups and control group

	Caseload care (MGP)	Young women's clinic (YWC)	Standard care (control group)
First visit	• Primary MGP midwife conducts a home visit • One of two obstetricians conducts obstetric visit at the community venue	• One of four YWC midwives conducts visit in community venue • One of two obstetricians conducts obstetric visit at the community venue	• Rostered midwife conducts visit in a community or hospital clinic • Hospital-based obstetric visit with junior or senior obstetrician
Subsequent antenatal care	• All four MGP midwives provide group antenatal care at community venue	• One of four YWC midwives provides individual visits at community venue	• Rostered midwives provide individual visits in a community or hospital clinic.
Relationship with care providers	• Continuity of carer with a primary MGP midwife • Meets the back-up MGP midwives at group antenatal care • Continuity of care from one of two obstetricians	• Continuity of care from four rostered midwives • Continuity of care from one of two obstetricians	• Maternity care provided by multiple different midwives and obstetricians. • Some women see a family physician
Antenatal planning and support	• Weekly conferences of complex cases includes input and planning from MGP and YWC midwives, an obstetrician, social worker and child protection • On-site psychosocial assessment and support available from a social worker, who can see women immediately if required • Peer support workers assist with housing, income support, legal issues and access to education and training		• Referral to a risk planning meeting with clinicians and allied health unfamiliar with the individual • Referral to allied health with typical two week wait time • No direct access to this community-based service
After hours contact	• Primary or back-up MGP midwife available 24 hours a day via mobile telephone	• Rostered midwife available via hospital telephone number	

Intrapartum care	• Primary or back-up MGP midwife in the birth suite • Known midwifery carer in labour is provided • Obstetric care by rostered doctors is provided if indicated	• Rostered midwife in the birth suite • Known midwifery carer in labour is not provided • Obstetric care by rostered doctors is provided if indicated
Inpatient postnatal care	• Provided by rostered doctors, nurses and midwives who are unfamiliar to the women.	
Outpatient postnatal care	• Primary or back-up MGP midwife provides home visits for six weeks • Known midwifery carer is provided	• Known midwifery carer is not provided • Rostered midwives provide home visits for 10-14 days
Midwives conditions	• Caseload midwives are employed on an annual salary. They work in cycles of 152 hours over four (4) weeks; and do not work in excess of twelve (12) consecutive hours in any twenty four (24) hour period • Each midwife cares for about 35-40 women per annum; and provides back-up care for a further 35-40 women	• Midwives are rostered prospectively to individual work units. They may rotate across all shifts and between work areas • Rostered midwives are paid according to the award for their level of service and whether they are full time (38 hours per week) or part time

Table 2 Background demographics and antenatal risk factors[a] (by treatment-received)

Baseline characteristics	Standard care (n=1038)	Caseload care (n=627)	Young women's clinic (n=306)	p value
Age (years)	20 (2)	19 (2)	19 (2)	<0.001
Adolescent multiparity[b]	84 (8%)	28 (4%)	23 (7%)	0.015
Nulliparity	736 (71%)	534 (85%)	250 (82%)	<0.001
Ethnicity[c]				
Caucasian	561(54%)	486 (78%)	209 (68%)	<0.001
Aboriginal and/or Torres Strait Islander	141 (14%)	16 (3%)	18 (6%)	
Maori and/or Pacific Islander	72 (7%)	64 (10%)	35 (11%)	
Other e.g. Asian, African, Middle-Eastern	262 (25%)	60 (10%)	44 (14%)	
Socio-Economic Index For Areas[d]				
SEIFA 1	274 (27%)	123 (20%)	45 (15%)	<0.001
SEIFA 2	34 (3%)	10 (2%)	5 (2%)	
SEIFA 3	188 (18%)	86 (14%)	61 (20%)	
SEIFA 4	252 (24%)	176 (28%)	77 (25%)	
SEIFA 5	286 (28%)	232 (37%)	118 (39%)	
Relationship status, single[e]	554 (54%)	341 (55%)	188 (63%)	0.023
Smoking at booking[f]	295 (28%)	149 (24%)	86 (28%)	0.097
History of illicit drug use[g]	247 (24%)	203 (33%)	1(37%)	<0.001
Pre-pregnancy body mass index[h]	22.46 (6.63)	22.43 (6.12)	22.72 (6.17)	0.642
History of sexually transmitted infection	58(6%)	49 (8%)	26 (9%)	0.089
History of mental illness[i]	163 (16%)	153 (24%)	72 (24%)	<0.001
Psychology referral offered and accepted[j]	21 (2%)	47 (8%)	12 (4%)	<0.001
History of family involvement with Department of Child Safety[k]	53 (5%)	60 (10%)	18 (6%)	0.002
Social work referral offered and accepted[l]	320 (31%)	317 (51%)	137 (48%)	<0.001

Medical / obstetric risk factors				
At hospital booking	132 (13%)	46 (7%)	25 (8%)	0.001
At onset of labour	113 (11%)	35 (6%)	17 (6%)	<0.001
Hospital admission during pregnancy	61 (6%)	26 (4%)	7 (2%)	0.024
At booking and/or onset of labour	191 (18%)	69 (11%)	33 (11%)	<0.001

Table 2 Legend

Categorical data are analysed with a chi-squared or Fisher's exact test and are presented as n (%). Continuous data are analysed with Kruskal-Wallis test and/or Wilcoxon rank sum test and are presented as median {interquartile range}.

a. The complete data set (n=1971) was used in the analysis of secondary outcomes. Missing data are reported for each data item.
b. Adolescent multipara defined as participants aged 19 years or less who gave birth to a subsequent baby. This definition has been used because there is an association between giving birth to a subsequent baby aged 19 years or less, and a three-fold increase in the risk of preterm birth (Smith & Pell, 2001).
c. Ethnicity missing data n=3.
d. The Socio-Economic Indexes for Areas (SEIFA) was used to categorise socio-economic status. SEIFA divides areas into quintiles based on postcode with reference to income, education, employment, occupation, housing and other indicators of advantage and disadvantage. SEIFA quintile is used here; score of 1 is the lowest and 5 is the highest. Missing data n=4.
e. Relationship status was defined dichotomously as partnered (married, defacto) or un-partnered (single, widow); missing data n=23.
f. Smoking during pregnancy was either smoking or not smoking as self-reported at the booking visit; missing data n=2.
g. History of illicit drug use during pregnancy was either any history of drug use (e.g. cannabis, cocaine, heroin) or no history of drug use as self-reported at the booking visit; missing data n=15.
h. Pre-pregnancy body mass index; missing data n=32.
i. Mental health condition was analysed as any self-reported history of mental health diagnosis (e.g. depression, anxiety, schizophrenia), compared to no previous mental health diagnosis; missing data n=3.
j. Psychology referral; missing data n=1
k. Department of Child Safety involvement; 'not able to ask' considered as missing data n=18; additional missing data i.e. question not answered n=3.
l. Social work referral; missing data n=1

Table 3 Analysis for primary outcomes by intention-to-treat (ITT) and treatment-received (TR)

		Standard	Caseload	Young women's clinic	Caseload vs. Standard		YWC vs. Standard	
					Odds ratio (95% CI)	p value	Odds ratio (95% CI)	p value
Preterm birth	**ITT**	103 (11%)	35 (6%)	30 (8%)	OR 0.48 (0.32-0.71) **aOR[a] 0.59 (0.38-0.90)**	<0.001 **0.014**	OR 0.65 (0.43-1.00) aOR[a] 0.79 (0.50-1.25)	0.048 0.313
	TR	110 (11%)	35 (6%)	23 (8%)	0.50 (0.34-0.74) **aOR[a] 0.65 (0.42-0.99)**	0.001 **0.042**	0.68 (0.43-1.09) aOR[a] 0.84 (0.51-1.37)	0.113 0.476
Low birth weight infant	**ITT**	89 (10%)	28 (5%)	19 (5%)	OR 0.45 (0.29-0.69) aOR[b] 0.74 (0.41-1.37)	<0.001 0.340	OR 0.47 (0.30-0.80) **aOR[b] 0.49 (0.24-1.00)**	0.004 **0.049**
	TR	95 (9%)	28 (5%)	13 (4%)	0.47 (0.30 – 0.72) aOR[b] 0.79 (0.43-1.44)	0.001 0.441	0.44 (0.24-0.80) aOR[b] 0.46 (0.21-1.00)	0.007 0.051
Admission to neonatal intensive care unit	**ITT**	61 (7%)	14 (2%)	13 (3%)	OR 0.33 (0.18-0.59) **aOR 0.42[c] (0.22-0.82)**	<0.001 **0.010**	OR 0.48 (0.26-0.88) aOR 0.56[c] (0.28-1.09)	0.018 0.089
	TR	67 (7%)	12 (2%)	9 (3%)	0.28 (0.15-0.53) **aOR[c] 0.35 (0.18-0.69)**	<0.001 **0.003**	0.44 (0.22-0.89) aOR[c] 0.54 (0.25-1.17)	0.022 0.117
Breastfeeding initiation[d]	**ITT**	687 (79%)	494 (83%)	317 (83%)	OR 1.38 (1.05-1.80) aOR[e] 1.31 (0.92-1.84)	0.020 0.130	1.36 (0.99-1.85) aOR[e] 1.39 (0.95-2.05)	0.057 0.092
	TR	783 (79%)	513 (84%)	250 (83%)	1.41 (1.08-1.83) aOR[e] 1.24 (0.89-1.75)	0.011 0.208	1.33 (0.95-1.87) aOR[e] 1.17 (0.78-1.77)	0.094 0.442

Table 3 Legend

Grey shaded results by intention-to-treat analysis (n=1908): Standard (n=910), Caseload (n=607), Young women's clinic (n=391). Unshaded results by treatment-received analysis (n=1908): Standard (n=1007), Caseload (n=604), Young women's clinic (n=297). Outcome data are reported as n (%). Odds Ratios (OR) and Adjusted Odds Ratios (aORs) are presented with 95% Confidence Intervals (CIs) and Probability values (p value).

a. Adjusted for antenatal attendance, body mass index (BMI), ethnicity, marital status, medical and/or obstetric risk, smoking at booking, and socio-economic status.
b. Adjusted for antenatal attendance, BMI, ethnicity, medical and/or obstetric risk, preterm birth, smoking at booking and socio-economic status.
c. Adjusted for antenatal attendance, caesarean birth, ethnicity, low birth weight, preterm birth, smoking at booking and socio-economic status.
d. Breastfeeding initiation includes breastfeeding and/or expressed breast milk only. Stillborn babies excluded. Feeding recorded as either 'not applicable', 'gavage' or 'other' treated as missing data (n=64).
e. Adjusted for admission to a neonatal nursery, birth weight, BMI, ethnicity, marital status, maternal age, medical and/or obstetric risk, mode of birth, nulliparity, opioids / regional analgesia in labour, preterm birth, smoking at booking, and socio-economic status.

Table 4 Bivariate analysis for secondary outcomes[a] by treatment received (model of care on admission for labour / birth)

	Standard care (n=1038)	Caseload care (n=627)	Young women's clinic (n=306)	p value
Maternal Outcomes				
Less than five antenatal visits	120 (12%)	41 (7%)	24 (8%)	0.002
Antenatal hospitalisation	88 (8%)	44 (7%)	18 (6%)	0.256
Labour onset				
Spontaneous	693 (67%)	434 (69%)	217 (71%)	0.312
Induction	276 (28%)	176 (29%)	74 (25%)	0.531
Planned CS	69 (7%)	17 (3%)	15 (5%)	0.003
Labour augmentation				
Amniotomy[b]	252 (37%)	187 (44%)	98 (46%)	0.025
Oxytocin[c]	138 (20%)	119 (28%)	70 (32%)	<0.001
Analgesia in labour[d]				
Opiate analgesia	304 (29%)	195 (31%)	92 (30%)	0.724
Regional analgesia	374 (39%)	228 (37%)	129 (44%)	0.124
Mode of birth[e]				0.402
Spontaneous	737 (71%)	440 (70%)	205 (67%)	
Instrumental	112 (11%)	82 (13%)	42 (14%)	
Caesarean	189 (18%)	105 (17%)	59 (19%)	
Neonatal Outcomes				
Gestation at birth, median weeks[f]	39 (2)	40 (1)	39 (1)	<0.001
Birth weight, median grams[f]	3330 (700)	3450 (644)	3406 (690)	<0.001

Small for gestational age[g]	119 (12%)	60 (10%)	37 (12%)	0.436
Stillbirth	12 (1%)	5 (1%)	0 (0%)	0.154
Apgar <7 at 5 minutes[h]	30 (3%)	15 (2%)	1 (0.33%)	0.032
Admission to a separate neonatal nursery	129 (12%)	46 (7%)	24 (8%)	0.001
Breastfeeding on discharge[i]	740 (75%)	493 (80%)	220 (73%)	0.010

Table 4. Legend

a. The complete data set (n=1971) was used in the analysis of secondary outcomes. Missing data are reported for each data item.
b. of those who went into spontaneous labour (n=1354) and were augmented with ARM; missing data n=33.
c. of those who went into spontaneous labour (n=1354) and were augmented with oxytocin; missing data n=4.
d. Analgesia in labour excluded participants who did not labour i.e. had a planned caesarean section; missing data n=1.
e. Instrumental vaginal includes forceps and vacuum assisted births.
f. Two-sample Wilcoxon rank sum test; p value for significance adjusted to 0.025.
g. Small-for-gestational age, defined as <10th centile on customised birth weight model; missing data n=70.
h. Apgar score less than 7 at 5 minutes; missing data n=9.
i. Exclusive breastfeeding (breast and/or breastmilk) at the time of hospital discharge; missing data n=62.