Psychosocial Stratification of Antenatal Indicators to Guide Population-Based Programs in Perinatal Depression

John Eastwood (john.eastwood@health.nsw.gov.au)
Sydney Local Health District

Andy Wang
Sydney Local Health District

Sarah Khanlari
Sydney Local Health District

Alicia Montgomery
Sydney Local Health District

Jean Yee Hwa Yang
The University of Sydney

Research article

Keywords: Perinatal, Depression, Stratification, Integrated Care, Latent Class Analysis

DOI: https://doi.org/10.21203/rs.3.rs-97766/v1

License: This work is licensed under a Creative Commons Attribution 4.0 International License.
Read Full License
Abstract

Background:

There is increasing awareness that perinatal psychosocial adversity experienced by mothers, children, and their families, may influence health and well-being across the life course. To maximise the impact of population-based interventions for optimising perinatal wellbeing, health services can utilise empirical methods to identify subgroups at highest risk of poor outcomes relative to the overall population.

Methods:

This study sought to identify sub-groups using latent class analysis within a population of mothers in Sydney, Australia, based on their differing experience of self-reported indicators of psychosocial adversity. Subgroups differences in antenatal and postnatal depressive symptoms were then assessed, as measured by Edinburgh Postnatal Depression Scale scores recorded at antenatal booking and early postnatal assessments, respectively.

Results:

Latent class analysis identified four distinct subgroups within the cohort, who were distinguished empirically on the basis of their native language, current smoking status, previous involvement with Family-and-Community Services (FaCS), history of child abuse, presence of a supportive partner, and a history of intimate partner psychological violence. One group consisted of socially supported ‘local’ women who speak English as their primary language (Group L), another of socially supported ‘migrant’ women who speak a language other than English as their primary language (Group M), another of socially stressed ‘local’ women who speak English as their primary language (Group Ls), and socially stressed ‘migrant’ women who speak a language other than English as their primary language (Group Ms). Compared to local and not socially stressed residents (L group), the odds of antenatal depression were nearly three times higher for the socially stressed groups (Ls OR: 2.87 95%CI 2.10-3.94) and nearly nine times more in the Ms group (Ms OR: 8.78, 95%CI 5.13-15.03). Antenatal symptoms of depression were also higher in the not socially stressed migrant group (M OR: 1.70 95%CI 1.47-1.97) compared to non-migrants. In the postnatal period, Group M was 1.5 times more likely, while Ms group was over five times more likely, to experience suboptimal mental health compared to Group L (OR 1.50, 95%CI 1.22-1.84; and OR 5.28, 95%CI 2.63-10.63, for M and Ms respectively).

Conclusions:

This study demonstrates that it is possible to stratify pregnant women into subpopulations using their demographic and psychosocial characteristics, to identify those at greatest risk of suboptimal mental health in the antenatal and postnatal periods. The application of empirical subgrouping analysis permits an informed approach to targeted resource allocation for optimising perinatal maternal wellbeing.
Background

The association of adversity during pregnancy with poor pregnancy and childbirth outcomes is well established [1–3]. The antenatal stressors are broadly related to the intrauterine environment (e.g. nutrition; maternal stress; exposure to smoking, drugs and alcohol), psychosocial experience (e.g. interpersonal violence; loneliness; anxiety and depression), and socioeconomic context (e.g. low income; class; migrant; unemployment; education; housing) a mother has experienced and is currently experiencing [4].

The public health importance of this perinatal adversity is related to its demonstrated impact on multiple domains of childhood and adult outcomes across the life course [5, 6]. Of importance here is the intergenerational nature of this experience of adversity and the impact of mothers’ own childhood experience of adversity on her current pregnancy and childbirth outcomes.

There is an increasing understanding of the impact of exposure to adverse childhood experiences such as child maltreatment and exposure to domestic violence, and health and well-being outcomes across the life course. There is a strong dose-response relationship between exposure to adversity and poor health outcomes, including depression, anxiety, substance use, sexually transmitted diseases, suicide attempts, and a range of chronic diseases. Psychologically stressful experiences often compound those risks during adulthood as a result of ongoing intermittent partner violence, substance use, mental illness and social exclusion [7].

Young-Wolf and colleagues [8] note that there is a “growing body of literature suggesting that adverse childhood experiences are associated with increased mental health risks during pregnancy, including higher depressive symptoms, anxiety, suicidality, and substance use”. There is increasing interest in the role that maternal mental health plays in the intergenerational transmission of experienced adversity [9, 10]. In this study, we will focus on the impact of experienced adversity, as reported during antenatal booking, on perinatal depressive and anxiety symptoms as measured by the Edinburgh Depression Scale.

Pregnancy, childbirth and parenthood present a time of increased stress and vulnerability, placing women at higher risk of developing mood disorders in the perinatal period. If unrecognised or untreated, there are a range of adverse outcomes for women, their newborns and their families, including long-term neuropsychiatric sequelae in offspring. Globally, depression is a leading source of disease burden [11–13], with the prevalence of postpartum depression estimated to be 10–15 per cent worldwide on average, and in some countries can be as high as 40–45 per cent [14]. In Australia, it is estimated that 111,000 mothers were diagnosed with depression [15]. Of these, approximately one in two had perinatal depression, and over one in five was newly diagnosed during the perinatal period.

Significant relationships have been demonstrated between maternal depressive symptoms, their family and social circumstances, factors relating to community integration and ethnicity, and history of professional psychosocial support received [12, 16]. In particular, in the postpartum period, an increasing level of social support provision has a positive effect on decreasing depression risk [16, 17]. During the
antenatal period, depressive symptoms are indeed as prevalent amongst pregnant women [18], and its risk has similarly been shown to be reduced with having good social support [19]. Antenatal events and social circumstances, such as disease during pregnancy, family dissatisfaction or social isolation, have also been identified as risk factors for postnatal depression [11, 20]. Maternal depressive symptoms and events in the antenatal period are strongly associated with postnatal depressive symptoms and numerous adverse perinatal outcomes including preterm delivery and low birth weight [19, 21–25].

Psychosocial assessment during pregnancy can identify both risk and protective factors for the development of perinatal mood disorders. The New South Wales (NSW) Safe Start Policy [26] is a universally delivered programme for publicly booked pregnant women in the state of NSW, Australia. The programme incorporates antenatal and postnatal psychosocial assessment and the risk factors identified are used to organise further assessment and intervention. The Safe Start risk stratification framework was developed following a rigorous analysis of literature and expert policy advice. We are not aware of previous empirical studies that have sought to quantify the sub-populations at risk using latent class analysis or other cluster analysis approaches.

The study reported here is part of a translational psychosocial epidemiology study of perinatal adversity in Sydney Australia that aims to design perinatal and early childhood interventions that break the cycle of psychological trauma and adversity. The translational study has established a population cohort in the Sydney Local Health District (SLHD) and South Western Sydney Local Health District (SWSLHD), that will enable long-term modelling of outcomes in the local population and the impact of current and future health service interventions.

SLHD and SWSLHD are located in the Centre, Inner West and South Western regions of metropolitan of Sydney. In Sydney, the SLHD and SWSLHD cover 52% of the metropolitan area, with an estimated population of 1.6 million people of different cultural backgrounds [27, 28]. In the Sydney metropolitan area, more than half of the population spoke English at home (58.4%). Other most common languages spoken at home included Mandarin (4.7%), Arabic (4.0%) and Cantonese (2.9%) [29]. A number of maternal and child health services are provided to all communities across both districts, including those with socioeconomically disadvantaged populations [27, 28].

Here, we examined whether maternal sub-groups can be identified on the basis of their varying experiences of adversity, and whether the risk of antenatal and postnatal depressive symptoms differs between sub-groups, to inform maternal and child health service system redesign in Sydney.

Methods

This study utilised antenatal and postnatal data extracted from maternal and child health electronic medical records in the Sydney Local Health District (SLHD) and South Western Sydney Local Health District (SWSLHD), with ethical approval obtained from both health districts. The overall data sources used in this study have been described elsewhere [22, 30–34]. For this study, linked retrospective maternal and child health data of all live births in public health facilities in Sydney Local Health District
(SLHD) and South Western Sydney Local Health District (SWSLHD) between 2014 and 2015 (N = 17,751) were available. These data were routinely collected by qualified midwives as part of standard care provided to women during pregnancy and the postnatal period (within six weeks of birth). Non-English speaking pregnant women were provided with translated versions of the EPDS where available, produced by the New South Wales Multicultural Health Communication Service [35]. Alternatively, women completed the English version of the EPDS through accredited interpreters.

Of the 17,751 medical records available, a total of 8,105 participants were excluded due to incomplete information on psychosocial indicators that were mandatory to determine stratification class membership, with n = 9646 mothers included in subsequent analysis. These women had complete psychosocial data collected during their first antenatal encounter to enable assignment of group membership according to psychosocial stratification using latent class analysis, in addition to an Edinburgh Depression Scale (EPDS) score from an antenatal booking visit (n = 6,339), and/or a postnatal EPDS score (n = 4,848), as shown in Fig. 1.

Demographic variables utilised in this study included maternal age, gestational age at the first visit, pre-pregnancy BMI, smoking status, whether English was the first language or spoken at home, country of birth and Indigenous status. Psychosocial indicators were extracted from the electronic medical record to reflect the four critical antenatal psychosocial health assessment domains described in the ALPHA model [36], which include family factors, maternal factors, substance use and family violence. Available social indicators pertaining to family factors included presence or absence of a partner, report of having a supportive partner, previous involvement of statutory child protection agencies - Family-and-Community-Services (FaCS) or Out-of-Home-Care services (OoHC), and socioeconomic status. Socioeconomic status was calculated in accordance with the Australian Bureau of Statistics Socio-Economic Index for Areas [37], based on the mother's current residential address. Decile of socioeconomic status was categorised into High, Middle and Low groups (top 10 percent, middle percent and bottom 10 percent of the population respectively). Available social indicators pertaining to maternal factors included thoughts on history of self-harm, history of child abuse and history of physical or psychological intimate partner violence.

Individuals in this study were stratified into mutually exclusive subpopulations using latent class modelling on the basis of the above psychosocial indicator variables. Then, in a two-step approach, covariate analyses examined for associations between subgroup membership and Edinburgh Depression Scores (EPDS) obtained in the prenatal and postnatal periods separately.

The EPDS is a widely-used, multi-dimensional measures of maternal symptoms of anxiety [38, 39] and depression [40], with a total possible score of 30. In the present study, EPDS scores used to indicate suboptimal maternal mental wellbeing were selected based on previously published studies [41–44] and the current Australian endorsed guidelines on improving mental health outcomes for parents and infants [45]. For the purpose of this study, an EPDS of ≥ 9 was used as a binary variable to indicate suboptimal maternal mental health, in keeping with previous research indicating that an EPDS score of 9–12 is
indicative of clinically relevant maternal dysphoria [46], whilst an EPDS of $\geq 13$ is predictive of probable major depression) [47–49]. The EPDS has been validated across a range of cultures [47, 48, 50–53] and is superior to unstructured routine assessment in identifying indicators of suboptimal maternal mental health both internationally and in Australia [54–56].

**Statistical Analyses**

Latent class analysis (LCA) is an empirical approach to subgroup identification that classifies individuals into distinct categories based on differing patterns of ‘indicator’ variables, such that individuals within a group are more similar than individuals between groups [57]. In this study, LCA was conducted to identify subgroups within the overall population of women on the basis of varying experiences of adversity. Goodness-of-fit statistics were used to identify the optimal model and most likely number of classes to describe the underlying ‘class structure’ in this analysis via scree plot (including the log likelihood ratio, with higher values supporting models of better fit, and the Bayesian Information Criterion (BIC) and Akaike Information Criterion (AIC), with smaller values indicating better model fit). As the context of our study involves different social, ethnic and disadvantaged populations, we will henceforth refer to the latent classes as ‘groups’ to avoid unintentional negative connotations associated with the term ‘class.’

A swap-stepwise latent class model comparison approach was used to select the most informative variables (indicators) that characterise specific subgroup membership [58]. This is achieved by discarding those that are redundant (correlated), with intermittent swapping of variables in step-wise fashion, and comparing models with and without the assumption of independence between indicators.

A four-class latent class model was then re-fitted with the selected indicators to nominate each individual with a subpopulation group assignment. Using this approach, the variables that were selected for inclusion as indicators in this analysis included: English as a second language or born overseas, English spoken at home, current smoking status, family known to Family-and-Community Services (FaCS), history of child abuse, having a supportive partner, and history of intimate partner psychological violence. Other variables not found to be significantly influencing the latent class structure or redundant in this process included maternal age group, body mass index, reported alcohol use, late first antenatal visit (defined as greater than 20 weeks’ gestation), SEIFA of residence, having a partner, prior involvement with Out-Of-Home-Care services (OOHC), and known physical domestic violence.

Finally, risk of suboptimal perinatal mental health was assessed by odds ratio within each stratified subpopulation group, at both the first antenatal visit and the postnatal visit (within six weeks postpartum). Multivariate logistic regression modelling was performed to adjust for potentially confounding variables (represented by those that were not used at indicators in the latent class analysis as described above). All statistical analyses were performed using R.

**Results**

The cohort’s demographic and psychosocial characteristics are displayed in Table 1.
| Demographic Characteristics | Group L n (%) | Group Ls n (%) | Group M n (%) | Group Ms n (%) |
|-----------------------------|---------------|---------------|---------------|---------------|
| **Age at 1st antenatal visit, mean(sd)** | | | | |
| 20–39 years old | 29.93 (5.66) | 28.36 (6.16) | 31.12 (4.97) | 32.43 (5.90) |
| ≥ 40 years old | 4221 (92.3%) | 319 (90.37%) | 4372 (94.59%) | 86 (87.76%) |
| < 20 years old | 225 (4.92%) | 14 (3.97%) | 230 (4.98%) | 9 (9.18%) |
| **Pre-pregnancy BMI in kg/m², mean(sd)** | | | | |
| Underweight | 25.75 (6.13) | 25.61 (6.40) | 23.71 (4.83) | 24.80 (5.37) |
| Normal weight () | 186 (4.19%) | 37 (10.88%) | 350 (7.76%) | 7 (7.29%) |
| Overweight | 2260 (50.86%) | 145 (42.65%) | 2723 (60.36%) | 52 (54.17%) |
| Obese | 1083 (24.37%) | 80 (23.53%) | 969 (21.48%) | 23 (23.96%) |
|  | 915 (20.59%) | 78 (22.94%) | 469 (10.40%) | 14 (14.58%) |
| **Born overseas or ESL** | | | | |
| No | 4407 (96.37%) | 350 (99.15%) | 0 (0.00%) | 5 (5.10%) |
| Yes | 166 (3.63%) | 3 (0.85%) | 4622 (100.00%) | 93 (94.90%) |
| **Speaking English at home** | | | | |
| No | 4486 (98.10%) | 353 (100%) | 2357 (51.00%) | 60 (61.22%) |
| Yes | 87 (1.90%) | 0 (0%) | 2265 (49.00%) | 38 (38/78%) |
| **Indigenous Status** | | | | |
| No | 4426 (96.85%) | 286 (81.48%) | 4615 (99.94%) | 97 (98.98%) |
| Yes | 144 (3.15%) | 65 (18.52%) | 3 (0.06%) | 1 (2.21%) |
|                                   | Group L n (%) | Group Ls n (%) | Group M n (%) | Group Ms n (%) |
|-----------------------------------|---------------|---------------|---------------|---------------|
| **Socio-Economic Index for Areas** |               |               |               |               |
| Low                               | 830 (18.25%)  | 114 (32.48%)  | 1765 (40.33%) | 55 (56.70%)   |
| Medium                            | 3420 (75.21%) | 230 (65.53%)  | 2469 (56.42%) | 37 (38.14%)   |
| High                              | 297 (6.53%)   | 7 (1.99%)     | 142 (3.24%)   | 5 (5.15%)     |
| **Family Factors**                |               |               |               |               |
| Has a partner                     |               |               |               |               |
| No                                | 191 (4.21%)   | 106 (30.37%)  | 111 (2.43%)   | 26 (26.80%)   |
| Yes                               | 4345 (95.79%) | 243 (69.63%)  | 4459 (97.57%) | 71 (97.57%)   |
| Supportive Partner                |               |               |               |               |
| No                                | 65 (1.42%)    | 98 (27.76%)   | 110 (2.38%)   | 42 (42.86%)   |
| Yes                               | 4508 (98.58%) | 255 (72.24%)  | 4512 (97.62%) | 56 (57.14%)   |
| Known to Family-and-Community     |               |               |               |               |
| Services                          | 4573 (100.00%)| 164 (46.46%)  | 4622 (100.00%)| 62 (63.27%)   |
| No                                | 0 (00.00%)    | 189 (53.54%)  | 0 (0.00%)     | 36 (36.73%)   |
| Yes                               |               |               |               |               |
| Known to Out-of-Home-Care Services|               |               |               |               |
| No                                | 3285 (97.42%) | 196 (67.12%)  | 3465 (97.58%) | 64 (84.21%)   |
| Yes                               | 87 (2.58%)    | 96 (32.88%)   | 86 (2.42%)    | 12 (15.79%)   |
| **Maternal Factors**              |               |               |               |               |
| Thoughts of self-harm             |               |               |               |               |
| No                                | 4168 (98.96%) | 290 (92.36%)  | 4192 (98.94%) | 73 (85.88%)   |
| Yes                               | 44 (1.04%)    | 24 (7.64%)    | 45 (1.06%)    | 12 (14.12%)   |
| Gestational age at 1st antenatal visit, mean(sd) |               |               |               |               |
| <20 weeks                         | 12.57 (7.37)  | 14.46 (8.36)  | 12.49 (7.54)  | 15.55 (8.70)  |
| ≥ 20 weeks                        | 3749 (83.20%) | 255 (74.13%)  | 3760 (82.47%) | 62 (63.27%)   |
|                                   | 757 (16.80%)  | 89 (25.87%)   | 799 (17.53%)  | 36 (36.73%)   |
| **Substance Use**                 |               |               |               |               |
|                                      | Group L n (%) | Group Ls n (%) | Group M n (%) | Group Ms n (%) |
|--------------------------------------|---------------|----------------|---------------|---------------|
| Smoking status                       |               |                |               |               |
| No                                   | 4011 (87.71%) | 104 (29.46%)   | 4589 (99.29%) | 84 (85.71%)   |
| Yes                                  | 562 (12.29%)  | 249 (70.54%)   | 33 (0.71%)    | 14 (14.29%)   |
| Alcohol use                          |               |                |               |               |
| No                                   | 4407 (98.98%) | 325 (92.59%)   | 4533 (99.32%) | 93 (98.94%)   |
| Yes                                  | 91 (2.02%)    | 26 (7.41%)     | 31 (0.68%)    | 1 (1.06%)     |
| Family Violence                      |               |                |               |               |
| History of Child Abuse               |               |                |               |               |
| No                                   | 4145 (90.64%) | 166 (47.03%)   | 4585 (99.20%) | 63 (64.29%)   |
| Yes                                  | 428 (9.36%)   | 187 (52.97%)   | 37 (0.80%)    | 35 (35.71%)   |
| Intimate Partner Physical Violence   |               |                |               |               |
| No                                   | 4547 (99.56%) | 293 (83.00%)   | 4567 (99.22%) | 74 (75.51%)   |
| Yes                                  | 20 (0.44%)    | 60 (17.00%)    | 36 (0.78%)    | 24 (24.49%)   |
| Intimate Partner Psychological Violence |           |                |               |               |
| No                                   | 4573 (100.00%)| 297 (84.14%)   | 4608 (99.70%) | 52 (53.06%)   |
| Yes                                  | 0 (0.00%)     | 56 (15.86%)    | 14 (0.30%)    | 46 (46.94%)   |
| Perinatal Edinburgh Depression Scales (EDS) |           |                |               |               |
| Antenatal EDS, median (IQR)          |               |                |               |               |
| EDS< 9                               | 3 (5)         | 7 (7)          | 5 (6)         | 11 (10.5)     |
| EDS≥ 9                               | 3762 (86.66%) | 198 (60.37%)   | 3378 (78.41%) | 33 (37.93%)   |
|                                       | 673 (13.34%)  | 130 (39.63%)   | 930 (21.59%)  | 54 (62.07%)   |
| Postnatal EDS, median (IQR)          |               |                |               |               |
| EDS< 9                               | 3139 (90.23%) | 205 (87.23%)   | 2880 (86.41%) | 44 (47.69%)   |
| EDS≥ 9                               | 340 (9.77%)   | 30 (12.77%)    | 453 (13.59%)  | 21 (32.31%)   |
Latent Class Analysis

The scree plot suggested a three or four class model was most likely (Fig. 2). After examining the latent class structures for both the three- and four-class models, the four-class latent structure was considered to be the most valid on the basis of community experience. It consists of a subpopulation of women who speak English as their first language (described as 'local') (L), and a subpopulation who speak English as a second language (described as ‘migrant’) (M) women, who are either socially supported or socially-stressed (s).

The four subpopulation groups identified were: a) a majority group of local Australian residents with minimal social stressors (Group L, 47%, n = 4573); b) a small group of socially stressed local residents (Group Ls, 4%, n = 353); c) a majority group of migrants with minimal social stressors (Group M, 48%, n = 4622); and d) a small socially stressed migrant group (Group Ms, 1%, n = 98) (Fig. 3).

Maternal Antenatal Depression Scores by Subgroup

The mean (SD) age of the study participants at the first antenatal visit was 30.5 (SD 5.4) years old. The median EPDS score at the first antenatal visit was 4 (IQR = 6). 14% were considered to exhibit depressive symptoms with a score > 9. There was no EPDS score recorded for 582 women. The prevalence of depression in this cohort was 19.5% overall, and was 13.34%, 39.63%, 21.59% and 62.07% in Groups L, Ls, M and Ms respectively.

After adjustment, compared to local and not socially stressed residents (L group), the odds of depression were much higher for the socially stressed groups (Ls OR: 2.87 95%CI 2.10–3.94; Ms OR: 8.78, 95%CI 5.13–15.03), being nearly three times more in the Ls group and nearly nine times more in the Ms group. Antenatal depression was also higher in the not socially stressed migrant group (Ms OR: 1.70 95%CI 1.47–1.97) compared to non-migrants.

Maternal Postnatal Depression Scores by Subgroup

The median EPDS score at the postnatal visit was 3 (IQR = 5), with 9.1% having an EPDS score of more than 9. The prevalence of depressive symptoms indicated by an EPDS ≥ 9 in this cohort was 11.9% overall, and 9.77%, 12.77%, 13.59% and 32.31% in Groups L, Ls, M and Ms respectively, notably lower than the respective groups at the first antenatal visit.

After covariate adjustments, Group M was 1.5 times more likely, while Ms group was more than five times more likely, to experience suboptimal mental health in the postpartum period compared to Group L (OR 1.50, 95%CI 1.22–1.84; and OR 5.28, 95%CI 2.63–10.63, for M and Ms respectively).

Table 2 lists univariate and multivariate odds ratios between depression and each of the nine variables in the antenatal period, while Table 3 lists those in the post-natal period.
| Variable          | Level          | Univariate Estimates | Multivariate Estimates |
|-------------------|----------------|----------------------|------------------------|
|                   |                | OR  | OR 95%CI   | P       | OR  | OR 95%CI | p     |
| Group             | L (Ref)        |     |            |         |     |            |       |
|                   | Ls             | 4.08| 3.10, 5.37 | < 0.0001| 2.87| 2.10, 3.94| < 0.0001|
|                   | M              | 1.63| 1.42, 1.87 | < 0.0001| 1.70| 1.47, 1.97| < 0.0001|
|                   | Ms             | 11.04| 6.58, 18.51| < 0.0001| 8.78| 5.13, 15.03| < 0.0001|
| Age               | 20-39          |     |            |         |     |            |       |
|                   | ≥40            | 1.18| 0.91, 1.54 | 0.21    | 1.10| 0.84, 1.44| 0.51  |
|                   | <20            | 1.38| 0.72, 2.62 | 0.34    | 1.29| 0.64, 2.60| 0.48  |
| BMI               | Normal (Ref)   |     |            |         |     |            |       |
|                   | Underweight    | 1.14| 0.86, 1.53 | 0.36    | 0.96| 0.71, 1.31| 0.81  |
|                   | Overweight     | 1.20| 1.03, 1.40 | 0.02    | 1.23| 1.05, 1.44| 0.01  |
|                   | Obese          | 1.29| 1.08, 1.54 | 0.004   | 1.40| 1.17, 1.68| 0.0002|
| EtOH              | No (Ref)       |     |            |         |     |            |       |
|                   | Yes            | 1.88| 1.20, 2.92 | 0.005   | 1.70| 1.06, 2.71| 0.03  |
| Late 1st ANV      | No (Ref)       |     |            |         |     |            |       |
|                   | Yes            | 1.02| 0.86, 1.21 | 0.81    | 0.88| 0.74, 1.05| 0.1   |
| Partner           | Yes (Ref)      |     |            |         |     |            |       |
|                   | No             | 2.04| 1.58, 2.64 | < 0.0001| 1.41| 1.06, 1.88| 0.02  |
| DV.phy            | No (Ref)       |     |            |         |     |            |       |
|                   | Yes            | 5.24| 3.46, 7.92 | < 0.0001| 2.43| 1.52, 3.86| 0.0002|
| OOHC              | No (Ref)       |     |            |         |     |            |       |
|                   | Yes            | 2.16| 1.62, 2.87 | < 0.0001| 1.37| 0.99, 1.90| 0.06  |
| SEIFA.grp         | Medium (Ref)   |     |            |         |     |            |       |
|                   | Low            | 1.30| 1.13, 1.49 | < 0.001 | 1.08| 0.94, 1.26| 0.28  |
|                   | High           | 1.13| 0.82, 1.54 | 0.45    | 1.25| 0.91, 1.74| 0.17  |
### Table 3
Postnatal Period – Univariate estimates vs adjusted estimates.

| Variable | Level         | Univariate Estimates | Multivariate Estimates |
|----------|---------------|----------------------|------------------------|
|          |               | OR  | OR 95%CI | P     | OR  | OR 95%CI | p     |
| Group    | L (Ref)       |     |          |       |     |          |       |
|          | Ls            | 1.33 | 0.81, 2.19 | 0.26 | 1.25 | 0.73, 2.16 | 0.42 |
|          | M             | 1.47 | 1.21, 1.79 | <0.0001 | 1.50 | 1.22, 1.84 | 0.0001 |
|          | Ms            | 5.41 | 2.79, 10.49 | <0.0001 | 5.28 | 2.63, 10.63 | <0.0001 |
| Age      | 20-39         |     |          |       |     |          |       |
|          | ≥40           | 0.98 | 0.66, 1.45 | 0.91 | 0.89 | 0.60, 1.34 | 0.58 |
|          | <20           | 0.46 | 0.11, 1.91 | 0.28 | 0.65 | 0.16, 2.76 | 0.56 |
| BMI      | Normal (Ref)  |     |          |       |     |          |       |
|          | Underweight   | 0.66 | 0.40, 1.09 | 0.10 | 0.64 | 0.39, 1.06 | 0.08 |
|          | Overweight    | 1.12 | 0.89, 1.39 | 0.331 | 1.15 | 0.92, 1.44 | 0.21 |
|          | Obese         | 0.95 | 0.73, 1.24 | 0.70 | 1.04 | 0.79, 1.37 | 0.77 |
| EtOH     | No (Ref)      |     |          |       |     |          |       |
|          | Yes           | 1.48 | 0.78, 2.84 | 0.23 | 1.59 | 0.82, 3.07 | 0.17 |
| Late 1st ANV | No (Ref) |     |          |       |     |          |       |
|          | Yes           | 0.81 | 0.63, 1.06 | 0.13 | 0.77 | 0.59, 1.01 | 0.06 |
| Partner  | Yes (Ref)     |     |          |       |     |          |       |
|          | No            | 1.00 | 0.63, 1.59 | 0.99 | 0.99 | 0.55, 1.49 | 0.69 |
| DV.phy   | No (Ref)      |     |          |       |     |          |       |
|          | Yes           | 1.81 | 0.94, 3.49 | 0.08 | 1.42 | 0.68, 2.96 | 0.35 |
| OOHC     | No (Ref)      |     |          |       |     |          |       |
|          | Yes           | 1.35 | 0.85, 2.14 | 0.20 | 1.22 | 0.75, 2.00 | 0.42 |
| SEIFA    | grpMedium (Ref) |     |          |       |     |          |       |
|          | Low           | 1.13 | 0.92, 1.39 | 0.23 | 1.00 | 0.81, 1.24 | 0.99 |
|          | High          | 0.97 | 0.61, 1.55 | 0.90 | 0.98 | 0.61, 1.57 | 0.94 |
Discussion

The latent class analysis reported here has identified five clinical indicators that are strongly associated with a mother’s membership of a stressed subpopulation and her probability of having both antenatal and postnatal depressive symptoms. Using routinely available clinical and demographic antenatal data, women presenting to the antenatal care services were stratified into four groups that closely resembled the local community experience. The two demographic indicators identified were being born overseas and speaking English at home. The clinical indicators of psychosocial stress used in the final models were: a) having a supportive partner, b) known to Family-and-Community Services (child protection agency), c) smoking status, d) mothers’ history of child abuse, and e) known intimate partner psychological violence.

Depressive symptoms were higher among the two socially stressed groups compared to the two not stressed groups. Other psychosocial factors, not included in the LCA that influenced antenatal depression were pre-pregnancy BMI categories (i.e. being overweight or obese), alcohol use, presence or absence of a partner, and if there was known physical domestic violence. Our findings are consistent with previous studies that social stressors are associated with perinatal depression. In particular, our findings confirm that perinatal adversity is affecting pregnant women prenatally. An opportunity exists in addressing this by targeting socially stressed women in the Ls and Ms groups either prenatally, or early during pregnancy.

As previously reported the prevalence of postnatal depressive symptoms was higher in the migrant groups than in the local resident's groups. Importantly mothers who were members of socially stressed migrant groups were more than five times more likely to be depressed (OR: 5.28, 95%CI: 2.63–10.63). Previous studies have suggested that social isolation and a lack of social networks are important determinants of perinatal depression for migrants. The interplay between migrant women's social networks, integration and perinatal depression is complex. Migrants who reside in communities with a predominantly different cultural background to her own have been shown to have higher rates of depression [59–61]. This suggests that migrant women who integrate successfully into their local community, either within a community of their own cultural background or successfully integrate with a different cultural community, will assume the same psychosocial risks for perinatal depression as their local counterparts [62].

In addition, our results showed that migrant mothers, who were members of the not stressed group, were also more likely to have depressive symptoms postnatally than non-migrant mothers in the non-socially stressed group. It might be that these women found themselves more socially isolated and emotionally stressed in the community postpartum, and not fully utilise supportive services for early motherhood. The opportunity thus exists in providing community supporting services targeting migrants in the early period postpartum.

The study reported here has a number of limitations which we have described in previous analyses of this data set [22, 31, 63–65]. This includes data is collected from routinely recorded information in maternity and child health medical records and therefore has some missing data. In previous studies we have accommodated for missing values via imputation and previously reported studies found no significant
differences when with sensitivity analysis was undertaken between imputed and the original dataset. As noted earlier, in this study we excluded those records that had incomplete information. There are unmeasured variables such as social support, childhood adverse experiences and family structure that may be important for risk stratification. In addition, as previously reported, “our study was unable to differentiate mothers with pre-existing clinical depression from those with first-ever perinatal depressive symptoms” [31].

As argued above the public health importance of perinatal adversity to childhood and adult outcomes has been well described and accepted by the scientific community [5, 6]. There is a significant body of empirical research that has demonstrated that interventions are efficacious in study conditions [66, 67]. But when those interventions are taken to scale there is often a failure to achieve expected outcomes. This may be because those interventions were not tested on those with the greatest need, or because interventions are not delivered with the appropriate quality, reach and uptake by end users who will benefit most.

Systemic population-based approaches are required that identify those women who will benefit most from obstetric and psychosocial interventions. Those approaches will benefit from the development of analytical tools that can be used to improve the coordination, quality, dose and reach of clinical and public health interventions.

**Conclusion**

The analysis reported here has demonstrated that it was possible to stratify pregnant women into subpopulations using their demographic and psychosocial characteristics. Several distinct groups were highly predictive of both antenatal and postnatal depression. They are useful as tools in targeting further resource allocation to address depression in the antenatal and immediately postnatal periods. The study reported here will contribute to the development and assignment of evidence-based packages of care to pregnant women in Sydney. Importantly the study has confirmed the importance of supporting migrant women who are experiencing adversity and distress during, and after, pregnancy and childbirth.

**Abbreviations**

MatAgeGrp: Maternal age groups; BMI: Body mass index; EtOH: alcohol; Late1stANV: Late first antenatal visit; SEIFA: Social economic indexes for areas; OOHC: out of home care; DV.phy: physical domestic violence; EPDS: Edinburgh postnatal depression scale; NSW: New South Wales; SES: Socio-economic status; SLHD: Sydney Local Health District; SWSLHD: South Western Sydney Local Health District

**Declarations**

**Acknowledgements**
The authors are grateful to all the health professionals in South Western Sydney and Sydney Local Health Districts who spent time entering the data, and also to personnel in the Information Management & Technology Division for the time spent on generating the data for this analysis.

Funding

This study received no specific grant from any funding agency in the public, commercial or not-for-profit sectors.

Availability of data and materials

The data used for the analysis are accessed in accordance with ethical protocols that only allow unit record information to be released to investigators in the ethics committee submission for study approvals. Please send data requests and queries to South Western Sydney Local Health District Ethics committee. Postal Address: Research and Ethics Office Locked Bag 7103 LIVERPOOL BC NSW 1871 Australia Phone: + 61 (02) 8738 8304; Fax: + 61 (02) 8738 8310; email: research.support@sswahs.nsw.gov.au Sydney Local Health District Ethics committee c/- Research Ethics and Governance Office (REGO) Royal Prince Alfred Hospital Missenden Road CAMPERDOWN NSW 2050 Australia Telephone: + 61 (02) 9515 6766; Facsimile: + 61 (02) 95157176.

Authors’ contributions

JE conceptualised the study idea, obtained and prepared the data, prepared the manuscript, contributed to the interpretation of results and critically revised the manuscript. AW contributed to the conceptualisation of the research idea, performed the analysis, interpreted results, critically revised the manuscript. JYHY contributed to the conceptualisation of the research idea, assisted with interpretation of results, and critically revised the manuscript. SK contributed to the conceptualisation of the research idea and critically revised the manuscript. AM critically revised the manuscript. All authors read and approved the final manuscript as submitted.

Ethics approval and consent to participate

Ethics approvals for this study were obtained from the South Western Sydney Local Health District and the Sydney Local Health District Human Research Ethics Committees. No individuals were contacted for this study. Approval numbers HREC: LNR/11/LPOOL/463; SSA: LNRSSA/11/LPOOL/464 and Project No: 11/276 LNR; Protocol No X12–0164 and LNR/12/RPAH/266.

Consent for publication
Competing interests

The authors declare that they have no competing interests.

References

1. Khashan AS, McNamee R, Abel KM, Pedersen MG, Webb RT, Kenny LC, Mortensen PB, Baker PN: Reduced infant birthweight consequent upon maternal exposure to severe life events. Psychosom Med 2008, 70(6):688-694.

2. Bussieres E-L, Tarabulsy GM, Pearson J, Tessier R, Forest J-C, Giguere Y: Maternal prenatal stress and infant birth weight and gestational age: A meta-analysis of prospective studies. Dev Rev 2015, 36:179-199.

3. Flenady V, Koopmans L, Middleton P, Frøen JF, Smith GC, Gibbons K, Coory M, Gordon A, Ellwood D, McIntyre HD: Major risk factors for stillbirth in high-income countries: a systematic review and meta-analysis. The lancet 2011, 377(9774):1331-1340.

4. Kiernan K, Mensah F: Maternal indicators in pregnancy and children's infancy that signal future outcomes for children's development, behaviour and health: evidence from the Millennium Cohort Study. York: University of York 2009.

5. Alfano R, Guida F, Galobardes B, Chadeau-Hyam M, Delpierre C, Ghantous A, Henderson J, Herceg Z, Jain P, Nawrot TS: Socioeconomic position during pregnancy and DNA methylation signatures at three stages across early life: epigenome-wide association studies in the ALSPAC birth cohort. Int J Epidemiol 2018, 48(1):30-44.

6. Halfon N, Forrest CB, Lerner RM, Faustman EM: Handbook of life course health development. Cham, Switzerland: Springer; 2018.

7. Bellis MA, Hughes K, Ford K, Rodriguez GR, Sethi D, Passmore J: Life course health consequences and associated annual costs of adverse childhood experiences across Europe and North America: a systematic review and meta-analysis. The Lancet Public Health 2019.

8. Young-Wolff KC, Alabaster A, McCaw B, Stoller N, Watson C, Sterling S, Ridout KK, Flanagan T: Adverse childhood experiences and mental and behavioral health conditions during pregnancy: the role of resilience. J Womens Health 2019, 28(4):452-461.

9. Letourneau N, Dewey D, Kaplan BJ, Ntanda H, Novick J, Thomas JC, Deane AJ, Leung B, Pon K, Giesbrecht G: Intergenerational transmission of adverse childhood experiences via maternal depression and anxiety and moderation by child sex. Journal of developmental origins of health and disease 2019, 10(1):88-99.

10. Atzl VM, Narayan AJ, Rivera LM, Lieberman AF: Adverse childhood experiences and prenatal mental health: Type of ACEs and age of maltreatment onset. J Fam Psychol 2019, 33(3):304.
11. Fantahun A, Cherie A, Deribe L: Prevalence and Factors Associated with Postpartum Depression Among Mothers Attending Public Health Centers of Addis Ababa, Ethiopia, 2016. *Clinical practice and epidemiology in mental health: CP & EMH* 2018, **14**:196.

12. Ongeri L, Wanga V, Otieno P, Mbu J, Juma E, Vander Stoep A, Mathai M: Demographic, psychosocial and clinical factors associated with postpartum depression in Kenyan women. *BMC Psychiatry* 2018, **18**(1):318.

13. Rathod SD, Honikman S, Hanlon C, Shidhaye R: Characteristics of perinatal depression in rural central, India: a cross-sectional study. *Int J Ment Health Syst* 2018, **12**(1):68.

14. Vaezi A, Soojoodi F, Banihashemi AT, Nojomi M: The association between social support and postpartum depression in women: A cross sectional study. *Women and Birth* 2019, **32**(2):e238-e242.

15. Australian Institute of Health and Welfare: Perinatal depression: data from the 2010 Australian National Infant Feeding Survey (full publication; 19/06/2012 edition) In. Canberra, Australia: Australian Institute of Health and Welfare. ; 2012.

16. Sahin E, Seven M: Depressive symptoms during pregnancy and postpartum: a prospective cohort study. *Perspect Psychiatr Care* 2019, **55**(3):430-437.

17. Tambağ H, Turan Z, Tolun S, Can R: Perceived social support and depression levels of women in the postpartum period in Hatay, Turkey. *Nigerian journal of clinical practice* 2018, **21**(11):1525-1530.

18. Pampaka D, Papatheodorou SI, AlSeaidan M, Al Wotayan R, Wright RJ, Buring JE, Dockery DW, Christophi CA: Depressive symptoms and comorbid problems in pregnancy-results from a population based study. *J Psychosom Res* 2018, **112**:53-58.

19. Woldetensay YK, Belachew T, Biesalski HK, Ghosh S, Lacruz ME, Scherbaum V, Kantelhardt EJ: The role of nutrition, intimate partner violence and social support in prenatal depressive symptoms in rural Ethiopia: community based birth cohort study. *BMC Pregnancy Childbirth* 2018, **18**(1):374.

20. Do TKL, Nguyen TTH, Pham TTH: Postpartum depression and risk factors among Vietnamese women. *BioMed research international* 2018, **2018**.

21. Dayan F, Javadifar N, Tadayon M, Malehi AS, Komeili Sani H: The Relationship between Gestational Weight Gain and Postpartum Depression in Normal and Overweight Pregnant Women. *Journal of pregnancy* 2018, **2018**.

22. Eastwood J, Ogbo FA, Hendry A, Noble J, Page A, Group EYR: The impact of antenatal depression on perinatal outcomes in Australian women. *PLoS ONE* 2017, **12**(1):e0169907.

23. Mak JK, Lee AH, Pham NM, Tang L, Pan X-F, Binns CW, Sun X: Gestational diabetes and postnatal depressive symptoms: A prospective cohort study in Western China. *Women and Birth* 2019, **32**(3):e427-e431.

24. Mochache K, Mathai M, Gachuno O, Vander Stoep A, Kumar M: Depression during pregnancy and preterm delivery: a prospective cohort study among women attending antenatal clinic at Pumwani Maternity Hospital. *Annals of general psychiatry* 2018, **17**(1):31.

25. Ruohomäki A, Toffol E, Upadhyaaya S, Keski-Nisula L, Pekkanen J, Lampi J, Voutilainen S, Tuomainen T-P, Heinonen S, Kumpulainen K: The association between gestational diabetes mellitus and
postpartum depressive symptomatology: A prospective cohort study. J Affect Disord 2018, 241:263-268.

26. Mental Health and Drug and Alcohol Office: SAFE START Guidelines: Improving mental health outcomes for parents and infants. In. Sydney, NSW: Ministry of Health; 2010.

27. South Western Sydney Local Health District: Research Strategy for South Western Sydney Local Health District 2012–2021. In. Sydney, Australia: South Western Sydney Local Health District; 2012.

28. Sydney Local Health District: Planning Online. In.: Sydney Local Health District.; 2016.

29. Australian Bureau of Statistics: 2016 Census QuickStats Online. In.; 2019.

30. Ogbo FA, Eastwood J, Page A, Arora A, McKenzie A, Jalaludin B, Tennant E, Miller E, Kohlhoff J, Noble J: Prevalence and determinants of cessation of exclusive breastfeeding in the early postnatal period in Sydney, Australia. International Breastfeeding Journal 2017, 12:16.

31. Ogbo FA, Eastwood J, Hendry A, Jalaludin B, Agho KE, Barnett B, Page A: Determinants of antenatal depression and postnatal depression in Australia. BMC Psychiatry 2018, 18(1):49.

32. Ogbo FA, Ezeh OK, Khanlari S, Naz S, Senanayake P, Ahmed KY, McKenzie A, Ogunsiji O, Agho K, Page A: Determinants of Exclusive Breastfeeding Cessation in the Early Postnatal Period among Culturally and Linguistically Diverse (CALD) Australian Mothers. Nutrients 2019, 11(7):1611.

33. Khanlari S, Eastwood J, Barnett AM B, Naz S, Ogbo FA: Psychosocial and obstetric determinants of women signalling distress during Edinburgh Postnatal Depression Scale (EPDS) screening in Sydney, Australia. BMC Pregnancy Childbirth 2019, In Press.

34. Chaves K, Eastwood J, Ogbo F, Hendry A, Jalaludin B, Khanlari S, Andrew P: Intimate partner violence identified through routine antenatal screening and maternal and perinatal health outcomes. BMC Pregnancy Childbirth 2019, In Press.

35. Multicultural Health Communication Service [http://www.mhcs.health.nsw.gov.au/publicationsandresources#c3=eng&b_start=0&c4=edinburgh]

36. Carroll JC, Reid AJ, Biringer A, Midmer D, Glazier RH, Wilson L, Permaul JA, Pugh P, Chalmers B, Seddon F: Effectiveness of the Antenatal Psychosocial Health Assessment (ALPHA) form in detecting psychosocial concerns: a randomized controlled trial. CMAJ 2005, 173(3):253-259.

37. Pink B: Census of population and housing: socioeconomic index for areas. Canberra: Australian Bureau of Statistics 2013.

38. Grigoriadis S, de Camps Meschino D, Barrons E, Bradley L, Eady A, Fishell A, Mamisachvili L, Cook GS, O’Keefe M, Romans S et al: Mood and anxiety disorders in a sample of Canadian perinatal women referred for psychiatric care. Arch Womens Ment Health 2011, 14(4):325-333.

39. Tran TD, Tran T, La B, Lee D, Rosenthal D, Fisher J: Screening for perinatal common mental disorders in women in the north of Vietnam: A comparison of three psychometric instruments. J Affect Disord 2011, 133(1):281-293.

40. Kwan R, Bautista D, Choo R, Shirong C, Chee C, Saw SM, Chong Y-S, Kwek K, Meaney MJ, Rush AJ et al: The Edinburgh Postnatal Depression Scale as a measure for antenatal dysphoria. Journal of
41. Eastwood J, Ogbo FA, Hendry A, Noble J, Page A: The impact of antenatal depression on perinatal outcomes in Australian women. *PLoS ONE* 2017, 12(1):e0169907.

42. Eastwood JG, Phung H, Barnett B: Postnatal depression and socio-demographic risk: factors associated with Edinburgh Depression Scale scores in a metropolitan area of New South Wales, Australia. *Aust N Z J Psychiatry* 2011, 45(12):1040-1046.

43. Fox CR, Gelfand DM: Maternal depressed mood and stress as related to vigilance, self-efficacy and mother-child interactions. *Early Development and Parenting* 1994, 3(4):233-243.

44. Kohlhoff J, Hickinbotham R, Knox C, Roach V, Barnett Am B: Antenatal psychosocial assessment and depression screening in a private hospital. *Aust N Z J Obstet Gynaecol* 2016, 56(2):173-178.

45. Austin MP, Highet N, and the Expert Working Group: Mental health care in the perinatal period: Australian clinical practice guideline. In. Melbourne: Centre of Perinatal Excellence; 2017.

46. Khanlari S, AM BB, Ogbo FA, Eastwood J: Re-examination of perinatal mental health policy frameworks for women signalling distress on the Edinburgh postnatal depression scale (EPDS) completed during their antenatal booking-in consultation: a call for population health intervention. *BMC Pregnancy Childbirth* 2019, 19(1):221.

47. Boyce P, Stubbs J, Todd A: The Edinburgh Postnatal Depression Scale: Validation for an Australian Sample. *Aust N Z J Psychiatry* 1993, 27(3):472-476.

48. Murray L, Carothers AD: The validation of the Edinburgh Postnatal Depression Scale on a community sample. *Br J Psychiatry* 1990, 157:288-290.

49. Cox JL, Holden JM, Sagovsky R: Detection of postnatal depression. Development of the 10-Item Edinburgh Postnatal Depression Scale. *Br J Psychiatry* 1987, 150:782-786.

50. Rubertsson C, Börjesson K, Berglund A, Josefsson A, Sydsjö G: The Swedish validation of Edinburgh postnatal depression scale (EPDS) during pregnancy. *Nord J Psychiatry* 2011, 65(6):414-418.

51. Felice E, Saliba J, Grech V, Cox J: Validation of the Maltese version of the Edinburgh Postnatal Depression Scale. *Arch Womens Ment Health* 2006, 9(2):75-80.

52. Adouard F, Glangeaud-Freudenthal NM, Golse B: Validation of the Edinburgh postnatal depression scale (EPDS) in a sample of women with high-risk pregnancies in France. *Arch Womens Ment Health* 2005, 8(2):89-95.

53. Gibson J, McKenzie-McHarg K, Shakespeare J, Price J, Gray R: A systematic review of studies validating the Edinburgh Postnatal Depression Scale in antepartum and postpartum women. *Acta Psychiatr Scand* 2009, 119(5):350-364.

54. Barnett B, Lockhart K, Bernard D, Manicavasagar V, Dudley M: Mood disorders among mothers of infants admitted to a mothercraft hospital. *J Paediatr Child Health* 1993, 29(4):270-275.

55. Hearn G, Iliff A, Jones I, Kirby A,Ormiston P, Parr P, Rout J, Wardman L: Postnatal depression in the community. *Br J Gen Pract* 1998, 48(428):1064-1066.
56. Schaper A, Rooney B, Kay N, Silva P: Use of the Edinburgh Postnatal Depression Scale to identify postpartum depression in a clinical setting. *The Journal of Reproductive Medicine* 1994, **39**(8):620-624.

57. Jung T, Wickrama K: An introduction to latent class growth analysis and growth mixture modeling. *Social and personality psychology compass* 2008, **2**(1):302-317.

58. Fop M, Smart K, Murphy T: Variable Selection for Latent Class Analysis with Application to Low Back Pain Diagnosis. 2015.

59. Eastwood JG, Jalaludin BB, Kemp LA, Phung HN, Barnett BE: Immigrant maternal depression and social networks. A multilevel Bayesian spatial logistic regression in South Western Sydney, Australia. *Spat Spatiotemporal Epidemiol* 2013, **6**:49-58.

60. Falah-Hassani K, Shiri R, Vigod S, Dennis C-L: Prevalence of postpartum depression among immigrant women: a systematic review and meta-analysis. *J Psychiatr Res* 2015, **70**:67-82.

61. Eastwood J, Kemp L, Jalaludin B: “Being Alone and Expectations Lost”: A Realist Theory of Neighborhood Context, Stress, Depression, and the Developmental Origins of Health and Disease. *SAGE Open* 2018, **8**(1):2158244018763004.

62. King L, Feeley N, Gold I, Hayton B, Zelkowitz P: The healthy migrant effect and predictors of perinatal depression. *Women and Birth* 2019, **32**(3):e341-e350.

63. Ogbo FA, Eastwood J, Page A, Arora A, McKenzie A, Jalaludin B, Tennant E, Miller E, Kohlhoff J, Noble J: Prevalence and determinants of cessation of exclusive breastfeeding in the early postnatal period in Sydney, Australia. *Int Breastfeed J* 2017, **12**(1):16.

64. Khanlari S, Eastwood J, Barnett B, Naz S, Ogbo FA: Psychosocial and obstetric determinants of women signalling distress during Edinburgh Postnatal Depression Scale (EPDS) screening in Sydney, Australia. *BMC Pregnancy Childbirth* 2019, **19**(1):407.

65. Chaves K, Eastwood J, Ogbo FA, Hendry A, Jalaludin B, Khanlari S, Page A: Intimate partner violence identified through routine antenatal screening and maternal and perinatal health outcomes. *BMC Pregnancy Childbirth* 2019, **19**(1):357.

66. National Research Council and Institute of Medicine: *From Neurons to Neighbourhoods: The Science of Early Childhood Development*. Committee on Integrating the Science of Early Childhood Development. Washington, DC: National Academy Press; 2000.

67. Center on the Developing Child at Harvard University: *A Science-Based Framework for Early Childhood Policy: Using Evidence to Improve Outcomes in Learning, Behaviour, and Health for Vulnerable Children*: http://www.developingchild.harvard.edu; 2007.