Associations between social and behavioural factors and the risk of late stillbirth – findings from the Midland and North of England Stillbirth case-control study

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Objective To investigate behavioural and social characteristics of women who experienced a late stillbirth compared with women with ongoing live pregnancies at similar gestation.

Design Case-control study.

Setting 41 maternity units in the UK.

Population Women who had a stillbirth ≥28 weeks’ gestation (n = 287) and women with an ongoing pregnancy at the time of interview (n = 714).

Methods Data were collected using an interviewer-administered questionnaire which included questions regarding women’s behaviours (e.g. alcohol intake and household smoke exposure) and social characteristics (e.g. ethnicity, employment, housing). Stress was measured by the 10-item Perceived Stress Scale.

Main outcome measure Late stillbirth.

Results Multivariable analysis adjusting for co-existing social and behavioural factors showed women living in the most deprived quintile had an increased risk of stillbirth compared with the least deprived quintile (adjusted odds ratio [aOR] 3.16; 95% CI 1.47–6.77). There was an increased risk of late stillbirth associated with unemployment (aOR 2.32; 95% CI 1.00–5.38) and women who declined to answer the question about domestic abuse (aOR 4.12; 95% CI 2.49–6.81). A greater number of antenatal visits than recommended was associated with a reduction in stillbirth (aOR 0.26; 95% CI 0.16–0.42).

Conclusions This study demonstrates associations between late stillbirth and socio-economic deprivation, perceived stress and domestic abuse, highlighting the need for strategies to prevent stillbirth to extend beyond maternity care. Enhanced antenatal care may be able to mitigate some of the increased risk of stillbirth.

Keywords Domestic violence, perceived stress, perinatal mortality, risk factors, social determinants of health, socio-economic status, stillbirth, unemployment.

Tweetable Abstract Deprivation, unemployment, social stress & declining to answer about domestic abuse increase risk of #stillbirth after 28 weeks’ gestation.
Introduction

There are estimated to be 52,000 stillbirths a year in high-income countries (HICs), and although these represent a fraction of the global burden, there are disparities both between and within HICs, with the stillbirth rate varying from 1.3/1000 births after 28 weeks’ gestation in Iceland to 8.8/1000 births in Ukraine in 2015. The UK ranked 24th out of the 49 HICs with a stillbirth rate of 2.9/1000 births after 28 weeks’ gestation in 2015, with an annual rate of reduction of 1.4% between 2000 and 2015. In response to this, the UK government aims to reduce stillbirth rates by 50% by 2025; this has resulted in a series of initiatives to reduce stillbirth by improving maternity care.

Studies from a variety of HICs have demonstrated that women of low socio-economic status have an increased risk of stillbirth, with rates in the UK that are 1.9 times higher for those living in the most deprived areas than in the least deprived areas in 2016. The reasons for this are incompletely understood, as studies are not always able to adjust for potential confounding factors which are also associated with low socio-economic status such as cigarette smoking, educational status, ethnicity, migrant status, housing and social stress. The association between low socio-economic status and stillbirth suggests that in addition to improvements in maternity care, both preconceptions and antenatal interventions that address social factors may be required to reduce the stillbirth rate in HICs.

The Lancet Stillbirth Series in 2011 called for all HICs to achieve a stillbirth rate (≥28 weeks’ gestation) of 5/1000 or less, to reduce inequalities in stillbirth rate and to eliminate preventable stillbirths. Although the UK has successfully achieved the first objective, data from large observational studies and perinatal surveillance mechanisms indicate that variation and the higher stillbirth rate in women of low socio-economic status persists. The reasons for this need to be explored to develop intervention strategies which may reduce inequity in stillbirth rate for women of low socio-economic status. The Midlands and North of England Stillbirth Study (MiNESS) was conducted in a geographical region that includes a significant proportion of economically deprived areas, as measured by rates of unemployment and child poverty. The MiNESS aimed to identify modifiable causes of stillbirth; here we report analysis of social and economic factors and their association with late stillbirth.

Methods

MiNESS was a case-control study conducted in 41 secondary and tertiary UK maternity units between 1 April 2014 and 31 March 2016. Requisite ethical and research approvals were obtained (Ref 13/NW/0874) and the study was registered on www.clinicaltrials.gov (NCT02025530). MiNESS was conducted to address research questions prioritised by patients, the public and professionals. The study design and patient-facing study materials were reviewed and developed following consultation with the patient–public involvement group at the Maternal and Fetal Health Research Centre, University of Manchester. A core outcome set was not used in this research.

The study was conducted in accordance with the published protocol and the study methodology and findings have been described in detail previously. Briefly, cases where were included if the stillbirth occurred at or after 28 weeks’ gestation and the fetus did not have a congenital anomaly. Controls were women with an ongoing pregnancy prospectively recruited. To ensure controls were at a similar gestation to cases, the gestation at interview was frequency matched to the expected distribution of stillbirths based on distribution of cases in the preceding 4 years in that unit. Potential controls were randomly selected from the booking lists and the gestation, for interview calculated from their expected date of delivery. Women with multiple pregnancies, maternal age <16 years and an inability to give consent were excluded from the study.

Data were collected by an interviewer-administered questionnaire which included self-reported information on housing and employment status, cigarette smoking and use of alcohol or street drugs, exposure to domestic abuse and amount of physical exercise. Perceived stress was assessed using the Perceived Stress Scale, a 10-item questionnaire which has been validated in pregnancy; reported values in the upper quartile were considered high. Adequacy of antenatal care was assessed with regard to whether the number of antenatal visits recommended for the stage of pregnancy (at the time that the interview was conducted) was in accordance with national guidance, for example, a low-risk mother should have five antenatal visits by 28 weeks’ gestation and ten antenatal visits by 40 weeks’ gestation. When there were fewer attendances than recommended, this was deemed ‘inadequate’, when exactly the recommended number of contacts were achieved this was ‘adequate’, and if there were more clinic attendances than recommended this was ‘adequate plus’.

Respondents were asked questions about domestic abuse by the research midwife when they were on their own; if participants disclosed current domestic abuse, local safeguarding policies were followed, including referral to external agencies such as social services and the police. Participants were recorded being exposed to domestic abuse if they answered yes to any of the questions asking whether they had been hurt or frightened by someone close to them, whether they had been controlled or criticised, or
had been made to engage in sexual activity without consent.

For the main analysis, the level of socio-economic deprivation was determined by the Index of Multiple Deprivation (IMD), an area level score derived from the postcode of residence at the time of completion of the questionnaire. The IMD summarises seven aspects of deprivation: income, employment, health, disability, education, crime and living environment. This is a relative measure of deprivation which allows comparison of one small area with another. Quintiles of deprivation are allocated to all households in the UK. Women allocated to the most deprived quintile were those living in the 20% most deprived lower super output areas in England. To address whether there was selection bias, meaning that the control population was not representative of the women attending the maternity unit, deprivation scores for participants in the control group were compared with area-level socio-economic deprivation on all births at each included organisation from MBRRACE-UK (the organisation responsible for UK Perinatal Mortality Surveillance) for 2015. This was done with an alternative measure of deprivation used by MBRRACE-UK, the Children in Low Income Families Local Measure (https://www.gov.uk/government/statistics/personal-tax-credit-its-children-in-low-income-families-local-measure-2016-snapshot-as-at-31-august-2016) calculated by lower layer super output area (LSOA), a geographical area covering around 1500 residents and divided into quintiles based on all births in the UK. In addition, where possible the frequency of other behaviours, e.g. cigarette smoking, was compared with publicly available data for the study region.

Univariable analyses were carried out using logistic regression to estimate the effect of each variable. A multivariable model was developed for the additional social factors not included in the previously published multivariable model by including all those significant at the 10% level in univariable analysis and then reducing the model by removing non-significant variables one at a time (see footnote to Tables 2 and S1). The final multivariable model was created by adding the variables identified as remaining significant in this model, along with antenatal factors previously identified in relation to the risk of stillbirth in this study (maternal age, ethnicity, parity, education, smoking in pregnancy, marital status, pre-existing medical conditions, customised birthweight centile, sleep factors on the last night before stillbirth/interview [going to sleep position, sleep duration, number of times got up to toilet], naps in the daytime, gestation [at stillbirth/interview in controls] and study centre). All analyses were carried out using the logistic procedure in SAS v9.4 (SAS Institute, Cary, NC, USA) with a strata statement for maternity unit to allow for variation in the number of cases and controls across strata.

Results
Over the recruitment period, 3490 women were identified as potentially eligible participants for MiNESS (660 cases and 2830 controls; Figure 1). Of these women, 760 could not be contacted (77 cases [11%] and 683 controls [24%]) and 1700 women did not consent to participate (287 cases [43%] and 1413 controls [50%]). Six participants were excluded after data collection, as five stillbirths had previously unidentified congenital abnormalities detected on postmortem and one control participant had a stillbirth. Thus, there were 296 cases and 734 controls in the study population (response rates 44% and 26%, respectively).

Data on postcode to enable calculation of IMD were available on 287 cases and 714 controls (98.6% and 97.4% of participants included in analysis of the main study, respectively).

The demographic characteristics of the study population have been presented in detail previously. The majority of participants were from a white ethnic background (80.4% of cases and 81.0% of controls), with a smaller proportion of participants from South Asian (13.4% of cases and 13.0% controls) and black ethnic groups (4.1% of cases and 4.0% of controls). Participants’ ages were distributed across women’s reproductive lifespan, with the largest group aged between 30 and 34 years in both groups (29.6% cases, 36.6% controls). The median gestation at interview was 36\textsuperscript{3/4} weeks for controls (interquartile range [IQR] 32\textsuperscript{1/2} to 38\textsuperscript{1/2} weeks). For cases, the median gestation at diagnosis of stillbirth was 37\textsuperscript{4/4} weeks (IQR 33\textsuperscript{1/2} to 39\textsuperscript{1/2} weeks). The median time between the diagnosis of stillbirth and interview was 25 days (IQR 17–35). The most frequent factors associated with stillbirth were fetal growth restriction (45.2%), placental insufficiency (16.4%), placental abruption (6.5%) and acute infection (4.5%).

Women who participated in the control group of the MiNESS study had slightly higher levels of socio-economic deprivation and lower levels of home ownership than reported statistics for regions involved in the study or information calculated by MBRRACE-UK for participating maternity units, but there were similar levels of street drug use and reported domestic violence (Table 1). The prevalence of cigarette smoking was higher than that reported in national statistics. The level of alcohol consumption was lower than reported in other cohorts (Table 1).

The prevalence of each variable relating to social and economic status and their univariable odds ratios (OR) associated with stillbirth are presented in Table 2. In the univariable analysis, the following factors were associated with stillbirth: women in the lowest quintile of IMD score (i.e. the poorest women), women living in social housing or with ‘other’ housing arrangements (e.g. staying with
friends, no fixed abode), women on maternity leave, those who worked without pay or those who were unemployed, high levels of perceived stress, use of street drugs, exposure to domestic abuse or declining to answer the question, no moderate exercise in pregnancy and first- or second-hand exposure to cigarette smoke during the pregnancy.

Some exposures, for example use of street drugs, were rare; the agents used were cannabis ($n=11$), cocaine ($n=3$), heroin ($n=2$), methadone ($n=3$) and in two cases multiple street drugs. In the univariable analysis, use of any street drug was associated with an increased risk of stillbirth. Exposure changed through pregnancy, as most women (86.7%) who used street drugs reported cutting down, five following advice from a healthcare professional. Similarly, a few women indicated that they drank alcohol during pregnancy; those who did stated they drank one alcoholic drink per month. In the univariable analysis, consumption of one alcohol drink per month was not associated with a statistically significant altered risk of stillbirth, but after adjustment for co-variates, it was associated with a reduction in stillbirth (adjusted OR [aOR] 0.19, 95% CI 0.05–0.72).

When multivariable analysis was performed (Tables 2 and S1), the factor independently associated with the risk of late stillbirth was deprivation; however, there was not a stepwise trend moving from the least deprived quintile to most deprived; only the most deprived quintile demonstrated a statistically significant increase (aOR 3.16, 95% CI 1.47–6.77). Unemployed women had an increased risk compared with those who were working (aOR 2.32, 95% CI 1.00–5.38). Women who had a perceived stress score >15 (upper quartile of distribution, which indicates a high level of stress) had an increased risk compared with women who had a score beneath this threshold (aOR 1.80; 95% CI...
of women reporting domestic abuse.

cal examination of the placenta was carried out in all cases reporting domestic abuse (23.5% versus 60%). Histopathologically high rate of unexplained stillbirth and a low rate of 17 women who reported domestic abuse had a comparably high rate of unexplained stillbirth and a low rate of postmortem examination compared to women who did not report domestic abuse (23.5% versus 60%). Histopathological examination of the placenta was carried out in all cases of women reporting domestic abuse.

Discussion

Main findings

A variety of social and behavioural factors are independently associated with the risk of late stillbirth in the Midlands and North of England. Women who had a stillbirth were more likely to be from the most deprived quintile of the population, unemployed, report high levels of perceived stress and to decline to answer questions about domestic abuse. By contrast, women with a live birth had higher levels of engagement with antenatal care. This study builds on recent work exploring the association between deprivation and stillbirth which found that the disparity between the most and least deprived women is most evident for small-for-gestational-age infants, placental problems and congenital anomalies.15

Strengths and limitations

This study included information on many social and behavioural variables, which enabled adjustment for potential confounding factors. In addition, cases and controls were recruited from the same maternity units, removing a potential effect of the quality of healthcare available to women from deprived backgrounds. However, some data collected by self-report may be open to error, as participants may have been unwilling to disclose behaviours which may have been viewed negatively, e.g. use of street drugs or alcohol, or which might lead to dangerous repercussions (e.g. revealing domestic abuse). Recall bias may

Table 1. Frequency of social and behavioural characteristics of participants in the control group of MiNESS and nationally reported statistics

| Characteristic (n available data in MiNESS) | MiNESS control (n, (%)) | Reported data (%) | Source |
|--------------------------------------------|-------------------------|------------------|--------|
| Socio-economic deprivation (quintile) (n = 712) |                         |                  |        |
| 1 (Most deprived)                          | 165 (23.2)              | 18.3*            |        |
| 2                                          | 129 (18.1)              | 16.8*            |        |
| 3                                          | 115 (16.2)              | 15.9*            |        |
| 4                                          | 124 (17.4)              | 20.8*            |        |
| 5 (Least deprived)                         | 179 (25.1)              | 28.1*            |        |
| Home ownership (n = 726)                   | 413 (56.9)              | 64.0%**          | 2011 Census Data, Office of National Statistics accessed at https://webarc hive.nationalarchives.gov.uk/20160202163431/https://www.nomisweb.co.uk/census/2011/cps05ew |
| Cigarette smoking (n = 733)                | 127 (17.3)              | 10.6 – 13.5      |        |
| Alcohol consumption (n = 724)              | 44 (6.1)                | 14.0 – 32.0%     | O’Keeffe et al. BMJ Open 2015;5:e006323 |
| Use of street drugs (n = 733)              | 6 (0.8)                 | 0.8              |        |
| Disclosed physical or emotional abuse (n = 732) | 14 (1.9)               | 2.5 – 3.6        | Bacchus et al. BJOG 2004;111:441–445, Onifade et al. J Obstet Gynecol 2010;30:550–2, Wokoma et al. BJOG 2014;121:627–33. |

*Weighted mean average of unit statistics based upon number of participants in MiNESS.
**Weighted mean average based upon home ownership in healthcare regions participating in MiNESS.

0.99–3.25). Although reported exposure to domestic abuse in the preceding year was no longer associated with stillbirth in the multivariable model (aOR 2.95, 95% CI 0.87–10.00), declining to answer the domestic abuse questions remained statistically significant (aOR 4.12, 95% CI 0.16–0.42). Assuming a risk of stillbirth for a woman with no risk factors present of 2.9/1000 births, this increases to 9.2/1000 births for a mother who is in the most deprived quintile, to 6.8/1000 births in unemployed women, and to 9.0/1000 births in women who were subjected to domestic abuse. If all four risk factors are present (deprivation, unemployment, stress and domestic abuse) the stillbirth risk is 109.2/1000 births. There was no statistically significant association in the primary cause of stillbirth between women who did not report being exposed to domestic abuse, participants who declined to answer the questions about domestic abuse and those who disclosed domestic abuse (Table 3, P = 0.20 (Fisher’s Exact test); this could potentially be due to the small numbers of women disclosing domestic abuse. The 17 women who reported domestic abuse had a comparatively high rate of unexplained stillbirth and a low rate of postmortem examination compared to women who did not report domestic abuse (23.5% versus 60%). Histopathological examination of the placenta was carried out in all cases of women reporting domestic abuse.
have been an issue for some questions, e.g. the timing of exercise, smoking or drug use or the degree of perceived stress. It is also possible that participants were not fully representative of the population of women in that maternity unit introducing selection bias. These issues would be expected to lead to under-reporting of some exposures; however, the reported frequencies of adverse health behaviours or social circumstances did not appear to be low in the control group (Table 1), suggesting that selection bias is unlikely to account for the observed associations.

**Interpretation**

This study has identified some important associations between social factors and the risk of late stillbirth. We identified an association between domestic abuse in the preceding year (especially the reluctance to answer questions) and stillbirth. Although rates of exposure were lower than previously reported, this may be related to study design (disclosure of domestic abuse is increased by a prior ‘safe’ disclosure leading to mandatory reporting). A large American study which assessed the outcome of pregnancies in which domestic abuse was coded after delivery reported an association with stillbirth, however, the reported frequencies of adverse health behaviours or social circumstances did not appear to be low in the control group (Table 1), suggesting that selection bias is unlikely to account for the observed associations.

**Table 2. Social and behavioural factors which were independently associated with stillbirth following multivariable analysis. Please see Table S1 for all variables assessed. **Adjusted odds ratios (aORs) derived from multivariable analysis**

| Factor                                      | Case       | Controls   | OR STRATIFIED for hospital* | Adjusted OR** |
|---------------------------------------------|------------|------------|-----------------------------|---------------|
| Multiple Deprivation quintile (missing – 23) | **P = 0.01** | **P = 0.004** |                             |               |
| 1 – most deprived                           | 110 (38.3) | 213 (29.8) | **1.89 (1.15–3.13)**        | **3.16 (1.47–6.77)** |
| 2                                           | 45 (15.7)  | 143 (20.0) | 0.99 (0.57–1.72)            | 1.10 (0.48–2.51) |
| 3                                           | 52 (18.1)  | 133 (18.6) | 1.28 (0.75–2.18)            | 1.82 (0.82–4.04) |
| 4                                           | 44 (15.3)  | 123 (17.2) | 1.02 (0.59–1.77)            | 1.43 (0.63–3.26) |
| 5 – least deprived                          | 36 (12.5)  | 102 (14.3) | Reference                    | Reference      |
| Work (missing – 0)                           | **P < 0.0001** | **P = 0.03** |                             |               |
| Working                                     | 98 (33.7)  | 389 (53.1) | Reference                    | Reference      |
| Maternity leave                             | 88 (30.2)  | 161 (22.0) | **2.02 (1.42–2.88)**        | 1.62 (0.90–2.93) |
| No paid work                                | 63 (21.7)  | 126 (17.2) | **1.95 (1.32–2.90)**        | 1.74 (0.88,3.42) |
| Unemployed                                  | 42 (14.4)  | 57 (7.8)   | **3.46 (2.14–5.60)**        | **2.32 (1.00–5.38)** |
| Perceived Stress in last month (missing – 30)| **P < 0.0001** | **P = 0.01** |                             |               |
| Low                                         | 205 (73.5) | 616 (86.2) | Reference                    | Reference      |
| High                                        | 74 (26.5)  | 99 (13.8)  | **2.27 (1.59–3.25)**        | 1.80 (0.99–3.25) |
| Domestic abuse in last year (missing – 1)   | **P < 0.0001** | **P < 0.0001** |                             |               |
| No                                          | 129 (44.3) | 532 (72.7) | Reference                    | Reference      |
| Declined to answer                          | 145 (49.8) | 186 (25.4) | **4.03 (2.91–5.57)**        | **4.12 (2.49–6.81)** |
| Yes                                         | 17 (5.8)   | 14 (1.9)   | **5.49 (2.52–11.93)**       | 2.95 (0.87–10.00) |
| Alcohol in the last month (missing – 27)    | **P = 0.05** | **P = 0.01** |                             |               |
| Less than one                                | 266 (97.8) | 681 (93.9) | Reference                    | Reference      |
| 1 or more                                   | 6 (2.2)    | 44 (6.1)   | **0.42 (0.17–1.01)**        | **0.18 (0.05–0.69)** |
| Antenatal care (missing – 1)                | **P < 0.0001** | **P < 0.0001** |                             | **P < 0.0001** |
| Inadequate                                  | 49 (16.9)  | 51 (7.9)   | **1.83 (1.13–2.97)**        | **1.42 (0.67–3.04)** |
| Adequate                                    | 110 (37.9) | 194 (26.5) | Reference                    | Reference      |
| Adequate plus                                | 131 (45.2) | 488 (66.6) | **0.47 (0.34–0.65)**        | **0.26 (0.16–0.42)** |

*Statistically significant aORs shown in bold.

*Odds ratios were estimated in a univariable model with the addition of a strata statement as described in the Methods.

**Adjusted odds ratios derived from multivariable analysis adjusting for the following covariates: maternal age, ethnicity, parity, education, smoking in pregnancy, marital status, customised birthweight centile, sleep factors on the last night before stillbirth/interview (position went to sleep in, sleep duration, number of times got up to toilet), naps in the daytime, gestation (at stillbirth/interview in controls) and study centre. The model also controls for antibiotic use in pregnancy, caffeine intake in pregnancy, pre-existing medical conditions, maternal age, parity, maternal BMI and birthweight percentile.
statistically significant when confounding factors were considered due to associations between domestic abuse, psychological stress and unemployment. Women reporting domestic abuse had significantly higher levels of stress in the last month than other two groups (71% versus declined to answer [18%] and No [14%]), and unemployment (35% versus declined to answer [12%] and No [7%]). This is consistent with higher depression scores in women exposed to domestic abuse, which are highly correlated with perceived stress scores ($r = 0.71–0.75$). Women who declined to answer the question about domestic abuse had an increased risk of stillbirth. This might be an indication they had a positive history of domestic abuse. This observation likely reflects that participants were told in advance that a safeguarding protocol was instituted when domestic abuse was declared, but if no response was given, no measures could be instituted, so abuse may have gone undetected by the interview. The Confidential Enquiry into Maternal Deaths from 2011–2013 drew attention to the association between domestic violence and maternal death, with 36 homicides occurring during pregnancy or within 1 year of birth, 24% of which occurred in women known to have been the subject of domestic violence. Critically, 76% of these cases had no documented enquiry about domestic abuse. Our findings suggest that professional enquiry into domestic abuse and violence is not only essential from a maternal perspective but may benefit infant outcome, such as tailored information and support, flexible antenatal care which includes addressing women’s fears about involvement of children’s care.

Perceived stress in the preceding month, as assessed by a validated scale, was associated with stillbirth on the univariable analysis and of borderline statistical significance in the multivariable model. Wisborg et al. used the General Health Questionnaire to assess levels of psychological stress and reported a similar increased risk of stillbirth in individuals with a high level of stress (aOR 1.9; 95% CI 1.1–3.2). This was independent of complications developing in pregnancy and social factors which could lead to increased stress. The association with stillbirth is also consistent with increased frequency of adverse pregnancy outcomes, including small-for-gestational-age fetuses and preterm births in women who report high levels of stress.

The association between socio-economic deprivation and stillbirth in the UK was explored in a recent meta-narrative review, which identified a need to explore the interrelations between social and economic factors (e.g. deprivation, smoking, access to care) and to devise interventions which may mitigate the risk of stillbirth. The association between deprivation and stillbirths merits exploration to determine whether this is mediated by other population factors relevant to public health such as air pollution, use of central heating, presence of fungal spores or factors impacting at the individual level such as diet.

### Table 3. Primary cause of stillbirth grouped by the reported presence of domestic abuse

| Primary cause of death | No domestic abuse | Declined to answer questions on domestic abuse | Domestic violence disclosed | Total |
|------------------------|------------------|-----------------------------------------------|-----------------------------|-------|
| n (%)                  | n (%)            | n (%)                                        | n (%)                       | n (%) |
| A2.2 Acute infection   | 5 (3.9)          | 6 (4.2)                                      | 2 (11.8)                    | 13 (4.5) |
| A5 Fetal Maternal      | 2 (1.6)          | 4 (2.8)                                      | 0 (0)                       | 6 (2.1)  |
| Haemorrhage            |                  |                                              |                             |       |
| A7 Fetal Growth Restriction | 57 (44.2)   | 68 (47.2)                                    | 6 (35.3)                    | 131 (45.2) |
| B1 Umbilical cord prolapse | 0 (0)             | 1 (0.3)                                      | 0 (0)                       | 1 (0.3)  |
| B2 Constricting cord loop or knot | 5 (3.9)        | 5 (3.5)                                      | 0 (0)                       | 10 (3.5) |
| B4 Other umbilical cord | 0 (0)            | 1 (0.7)                                      | 1 (5.9)                     | 2 (0.7)  |
| C1 Placental Abruption | 8 (6.2)          | 9 (6.3)                                      | 2 (11.8)                    | 19 (6.6) |
| C4 Placental Insufficiency | 26 (20.2)    | 22 (15.3)                                    | 0 (0)                       | 48 (16.6) |
| D1 Chorioamnionitis    | 5 (3.9)          | 1 (0.7)                                      | 0 (0)                       | 6 (2.1)  |
| E1 Uterine rupture     | 0 (0)            | 1 (0.7)                                      | 1 (5.9)                     | 1 (0.3)  |
| F1 Maternal diabetes   | 6 (4.7)          | 2 (1.4)                                      | 1 (5.9)                     | 9 (3.1)  |
| F6 Obstetric Cholestasis | 0 (0)           | 1 (0.7)                                      | 0 (0)                       | 1 (0.3)  |
| G1 Intrapartum         | 0 (0)            | 1 (0.7)                                      | 0 (0)                       | 1 (0.3)  |
| I1 No cause identified | 15 (11.6)        | 23 (16.0)                                    | 4 (23.5)                    | 41 (14.1) |
| Total                  | 129 (44.5)       | 144 (49.7)                                   | 17 (5.9)                    | 290 (100) |
Underlying solutions before conception appear to lie within public policy, but health service interventions could also be targeted. Women from deprived backgrounds or who experience domestic abuse may access antenatal care later, perceive a lack of choice regarding their care, report various types of discrimination and challenges with accessibility, comprehensibility and trustworthiness of information, all of which affect engagement with care. In our study population, women in the most and least deprived quintiles had the highest proportions of more frequent antenatal care. For the most deprived women, this may represent attempts by health professionals to meet these women’s complex health and social care needs. Accessible, frequent antenatal care offers an opportunity to mitigate the increased risk of stillbirth.

Although the relation between stillbirth and the use of street drugs was difficult to assess due to the small numbers of participants reporting their use in our study, the univariable association between the use of street drugs and stillbirth was of a similar magnitude to self-reported drug use (aOR 2.54; 95% CI 1.52–4.26) and when measured by umbilical cord drug metabolites (aOR 1.94; 95% CI 1.16–3.27). The majority of women using street drugs in our study reported cutting down on the amount of their use to reduce the exposure for their baby, most frequently aided by advice and input from health professionals, suggesting that with appropriate antenatal input, exposure to this risk factor could be minimised. In contrast, the association between fetal alcohol exposure and stillbirth is unclear. Our study found infrequent alcohol exposure (~1 drink per month) was protective for stillbirth, which agrees with other large studies that report no association between stillbirth and alcohol exposure of ≥4 drinks per week (OR 1.28; 95% CI 0.76–2.18). Importantly, alcohol use in pregnancy is underreported and disclosure rates alter by the approach taken. Focused studies employing a conversational approach to screening for alcohol and drug use are advocated to enhance the accuracy and honesty of reporting in order to determine more accurately their contribution to late stillbirth.

**Conclusion**

This study demonstrates independent associations between socio-economic deprivation, perceived stress, domestic abuse and late stillbirth. As many of these risk factors have important effects on mother’s lifelong health as well as neonatal outcome, this deserves input from both public health and maternity services. Provision of antenatal care could mitigate some of these effects but the optimal means to deliver antenatal care with appropriate screening for domestic abuse, perceived stress, alcohol and drug use, combined with interventions to address disclosed problems, needs to be determined. Clinicians should be trained to recognise domestic abuse, deprivation, drug and alcohol misuse and the resulting stress, and should be aware of interventions and management pathways to reduce these risks for women and their babies.

**Disclosure of interests**

None declared. Completed disclosure of interest forms are available to view online as supporting information.

**Contribution to authorship**

AH, TS, DR, EM and LM contributed to all aspects of the study design and obtained funding. AH had overall responsibility for the study. JB co-ordinated the running of the study. ML and JT analysed the data with input from AH, JB, RC, BB, EM and LM. LS provided data analysis for comparison with the MBRACE-UK dataset. All authors were responsible for the drafting of the manuscript. All authors gave approval for the final version of the manuscript.

**Details of ethical approval**

This study was reviewed by NRES Committee North West – Greater Manchester Central Reference (13/NW/0874) on 24 January 2014.

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Data sharing statement
No additional data from the MiNESS study are available from a repository. Anonymised data are available on request from the corresponding author.

Supporting Information
Additional supporting information may be found online in the Supporting Information section at the end of the article.

Table S1. Social and behavioural factors and their relation to stillbirth.
Video S1: Author Insights.

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