OBSTETRICS

# Association between stillbirth ≥23 weeks gestation and acute psychiatric illness within 1 year of delivery

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**BACKGROUND:** Stillbirth has been associated with emotional and psychologic symptoms. The association between stillbirth and diagnosed postpartum psychiatric illness is less well-known.

**OBJECTIVE:** The purpose of this study was to determine whether women have a higher risk of experiencing clinician-diagnosed psychiatric morbidity in the year after stillbirth vs livebirth.

**STUDY DESIGN:** This retrospective cohort study used International Classification of Diseases, 9th Revision, Clinical Modification diagnosis and procedure codes to identify participants, exposures, and outcomes within the Florida State Inpatient and State Emergency Department databases. The first delivery of female Florida residents aged 13—54 years old from 2005—2014 was included; women with International Classification of Diseases, 9th Revision, Clinical Modification coding for psychiatric illness or substance use during pregnancy were excluded. The exposure was an International Classification of Diseases, 9th Revision, Clinical Modification diagnosis code during delivery hospitalization of a stillbirth at ≥23 weeks gestation. The primary outcome was a primary or secondary International Classification of Diseases, 9th Revision, Clinical Modification diagnosis code during an Emergency Department encounter or inpatient admission within 1 year of delivery for a composite of psychiatric morbidity: suicide attempt, depression, anxiety, posttraumatic stress disorder, psychosis, acute stress reaction, or adjustment disorder. The secondary outcome was a substance use composite of drug or alcohol use or dependence. We compared outcomes after delivery of stillbirth vs livebirth using multivariable logistic regression, adjusting for maternal sociodemographic factors, medical comorbidities, and severe intrapartum morbidity. We also used Cox proportional hazard models and tested for violation of the proportional hazard assumption to identify the highest risk time within the year after stillbirth delivery for the primary outcome, adjusting for the same factors and morbidities as in the logistic regression model.

**RESULTS:** A total of 8292 women with stillborn singletons and 1,194,758 with liveborn singletons were included. Within 1 year of hospital discharge after stillbirth, 4.0% of the women (n=331) had an Emergency Department encounter or inpatient admission that was coded for psychiatric morbidity; the risk was nearly 2.5 times higher compared with livebirth (1.6%; n=19,746); adjusted odds ratio, 2.47; 95% confidence interval, 2.20— 2.77). Women also had higher risk of having an Emergency Department encounter or inpatient admission coded for drug or alcohol use or dependence in the year after delivery of stillbirth vs livebirth (124 [1.5%] vs 7033 [0.6%]; adjusted odds ratio, 2.41; 95% confidence interval, 1.99—2.90). Cox proportional hazard modeling suggested that the highest risk interval for postpartum psychiatric illness was within 4 months of stillbirth delivery (adjusted hazard ratio, 3.26; 95% confidence interval, 2.63—4.04), although the risk remained high during the 4—12 months after delivery (adjusted hazard ratio, 2.42; 95% confidence interval, 2.13—2.76).

**CONCLUSION:** Coding for psychiatric illness or substance misuse in Emergency Department visits or hospital admissions in the year after delivery of livebirths was not uncommon, corresponding to nearly 2 per 100 women. However, having a stillbirth was associated with increased risk of both psychiatric morbidity (corresponding to 1 per 25 women) and substance misuse (corresponding to 3 in 100 women), with the highest risk of postpartum psychiatric morbidity occurring from delivery until 4 months after delivery.

**Key words:** anxiety, depression, postpartum, psychiatric illness, stillbirth, substance use

Pregnancy is a potent trigger for new psychiatric illness,[1,2] particularly after unexpected outcomes; unanticipated cesarean delivery,[3] unintended pregnancy,[4] miscarriage,[5] and perception of negative or traumatic birth experience[6] have each been associated with increased risk of new-onset depression after delivery. Stillbirth, defined as fetal death after 20 weeks of pregnancy before or during delivery,[7] is 1 of the most severe unexpected pregnancy outcomes. Stillbirth has been associated with self-reported emotional and psychologic sequelae, which includes depression, anxiety, and disenfranchised grief.[8–11]

Although there is an association between stillbirth and self-reported emotional distress, the impact of stillbirth on diagnosed postpartum psychiatric illness is less clear. Some previous studies are limited by self-disclosure of psychologic symptoms[10] or small study populations with no comparator groups.[12–14] Others are population-based but combine stillbirth and miscarriage[15] or abortion[16] into a single exposure, which undermines the ability to determine the specific association between stillbirth and postpartum psychiatric illness. Given that 1 in 160 deliveries in the United States is a stillbirth,[17] it is of crucial importance to determine whether having a stillbirth is associated with an increase in clinician-diagnosed psychiatric illness.

Using a state database, we aimed to determine the incidence of presentation for acute psychiatric care in the Emergency Department or inpatient hospital in the year after delivery of a singleton

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## AJOG at a Glance

### Why was this study conducted?

Stillbirth has been associated with emotional and psychologic symptoms, but the association between stillbirth and diagnosed postpartum psychiatric illness is less clear.

### Key findings

A total of 8292 women with stillbirth at ≥23 weeks gestation and 1,194,758 women with livebirth were included. Within 1 year of delivery, women had nearly 2.5 times higher risk of acute psychiatric morbidity after stillbirth vs livebirth delivery (4.0% vs 1.6%; adjusted odds ratio, 2.47; 95% confidence interval, 2.20−2.77).

### What does this add to what is known?

Postpartum psychiatric illness within 1 year of delivery of liveborn singletons is not uncommon but occurs significantly more often after stillbirth.

pregnancy and to ascertain whether having a stillbirth was associated with increased risk of acute psychiatric illness within 1 year, compared with having a livebirth. We hypothesized that the prevalence of acute psychiatric illness was uncommon in the year after livebirth but that stillbirth would be associated with increased risk of psychiatric illness compared with livebirths.

## Materials and Methods

We conducted a retrospective cohort study using the Florida State Inpatient Database and Emergency Department Database of the Agency for Healthcare Research and Quality's Healthcare Cost and Utilization Project (HCUP) from 2005−2015, including all in-hospital deliveries from the third quarter of 2005 through December 31, 2014.[18] The Inpatient and Emergency Department databases were linked on a patient-level via a visit linkage variable (VisitLink) in tandem with a timing variable (DaysToEvent)[18]; as such, we could include multiple hospital or Emergency Department visits in Florida across time while adhering to HCUP privacy regulations.[18] Deliveries in women 13−54 years old were identified via a validated algorithm with the use of the International Classification of Diseases, 9th Revision, Clinical Modification (ICD-9-CM) diagnosis and procedure codes.[19] For study purposes, the index delivery was defined as the first delivery within the database during the study timeframe, regardless of parity or subsequent deliveries; the duration of postpartum follow up was defined as 365 days after hospital discharge. Deliveries were restricted to liveborn singletons (ICD-9-CM codes 650 and V270) and stillbirth at ≥23 weeks gestation (ICD-9-CM codes 656.40, 656.41, and V271). Women whose index deliveries were coded as both liveborn singletons and stillbirth at ≥23 weeks gestation or multiple gestation (ICD-9-CM codes 651.00, 651.01, 651.10, 651.11, 651.20, 651.21, V272, and V275) were excluded from analysis. Patients listed as "male" were excluded, as were female non-Florida residents because their long-term outcomes may not be captured in the database. In addition, women coded during an inpatient hospitalization or Emergency Department encounter in the 252 days before hospital discharge of the index delivery for any condition within the primary and secondary composite outcomes were excluded from analysis because of preexisting psychiatric illness during pregnancy. Sociodemographic data that were analyzed included age, race/ethnicity (non-Hispanic black, non-Hispanic white, Hispanic, and other), payer (private, public, or other), and income quartile by zip code. We also identified and analyzed underlying maternal medical comorbidities that were identified during delivery hospitalization and severe intrapartum maternal morbidity (SMM). The maternal comorbidity was a composite derived by a previously validated maternal comorbidity index[20]; SMM was defined by the Center for Disease Control and Prevention's SMM composite.[21] Individual indices for comorbidities and SMM were extracted with the use of ICD-9-CM diagnosis and procedure codes (Appendices A: Tables A1 and A2).

Outcomes were extracted from the day after index delivery hospital discharge through 365 days after discharge. The primary outcome was presentation to the Emergency Department or readmission to an inpatient hospital for treatment of an acute psychiatric illness, defined as a condition within the psychiatric morbidity composite. Our primary outcome combined psychiatric composites that have been used previously in the obstetric literature[2,5,16,22,23] and include suicide attempt, depression, anxiety, psychosis, posttraumatic stress disorder, acute stress reaction, and adjustment disorder. The secondary outcome was a substance use composite that included alcohol or recreational drug use or dependence, with the use of the Elixhauser comorbidity algorithm, which is a dichotomous categorization of ICD-9-CM code-−based morbidity that has been well-validated for administrative datasets.[24] The ICD-9-CM diagnosis codes for each condition within the primary and secondary outcomes are included in Appendix A: Table A3. Only the first Emergency Department presentation or hospital admission that met our primary or secondary outcome definition during the time interval was included. Coding for either primary or secondary diagnoses of any condition within each composite during a postpartum encounter was included as an outcome. Patients who were included in each composite outcome may have had >1 diagnosis within the composite but were counted only once per composite.

Demographic and baseline clinical data were compared between women who had stillbirth vs livebirth with the use of the $X^2$ test or Fisher's exact test for categoric variables, as appropriate.

Observations were censored at the first of the following conditions: 365 days after the index delivery hospital discharge, death, or subsequent hospitalization coded for pregnancy. Subsequent hospitalization coded for pregnancy was identified via ICD-9-CM diagnosis and procedure codes for pregnancy-related conditions or delivery after the index delivery (Appendix A: Table A3). Multivariable logistic regression analyses were adjusted for age, race/ethnicity, payer, income quartile by zip code, mode of delivery, maternal medical comorbidities, and SMM. Demographic data that were missing from the database were recoded as an indicator variable to ensure all patients were included in the multivariable analyses. A 2-sided probability value of $<.05$ was considered statistically significant in all analyses. Because of HCUP restrictions, counts <11 are reported as "—" to preserve patient privacy.

Additional prespecified analyses were performed to further evaluate our findings. We conducted Cox proportional hazard ratios to examine the association between stillbirth (and term livebirth) and the primary outcome over the 12-month follow-up period. The logrank test was used to compare survival functions. The proportional hazards assumption was assessed by significance testing of a time-dependent interaction. In anticipation that the risk of postpartum psychiatric morbidity was not consistent during the year-long follow-up period, additional Cox proportional hazard models were created to explore the highest risk window for postpartum psychiatric morbidity in clinically relevant intervals; the 12-month follow-up period was to be divided into 6-month, 4-month, and 3-month intervals, if needed. Once significance testing of a time-dependent interaction showed the proportional hazards assumption was not violated, the Heaviside unit step function was used to accommodate for variations in time-dependent interactions in the follow-up period.[25] We also tested whether significant interactions existed between independent variables within the primary logistic model. We redefined our outcomes to include only hospital admissions (ie, excluding Emergency Department encounters) to analyze the impact of having a stillbirth on postpartum psychiatric morbidity severe enough to require inpatient psychiatric care.

In addition, we conducted several sensitivity analyses. First, we redefined the exclusion period for preexisting psychiatric comorbidity as 2 years before the index delivery to exclude women with significant psychiatric illness who did not have any acute events during their pregnancy. Second, we excluded women who had medical comorbidities and/or SMM that was identified during their delivery hospitalization to confirm these factors were not confounding our results. Third, we removed psychosis as both an exclusion for a preexisting psychiatric morbidity and as a condition within the primary composite outcome. This was done because, although psychosis has been described as a mood disorder in obstetric literature,[2,22,26] psychosis is categorized as a psychotic disorder in the *Diagnostic and Statistical Manual of Mental Disorders, 5th Edition* (DSM-5).[27]

The Washington University in St. Louis Human Research Protection Office exempted this study from review because the HCUP data consist of limited datasets with no personally identifiable information. SAS statistical software (version 9.3; SAS Institute, Inc, Cary, NC) was used for all analyses.

## Results

A total of 1,239,462 singleton pregnancies were identified; 8812 deliveries (0.7%) were of a stillbirth at ≥23 weeks gestation, and 1,230,673 deliveries (99.3%) were livebirth. Of these, 447 stillbirths (5.1%) and 35,895 livebirths (2.9%) were excluded because of preexisting psychiatric morbidity. Appendix B compares psychiatric conditions that were identified during the index pregnancy or during the index delivery hospitalization that resulted in exclusion from analysis. The final analytic population included 8292 stillbirths at ≥23 weeks gestation and 1,194,758 livebirths.

Sociodemographic and obstetric characteristics between women who delivered stillbirths at ≥23 weeks gestation and liveborn singletons are shown in Table 1. Women with stillbirth were significantly more likely to be <18 years old or be >35 years old, be black, have public insurance, and have a vaginal delivery. Women with stillbirth were significantly more likely to be in the 3 lower income quartiles by zip code, particularly in the lowest income quartile, when compared with women who delivered livebirths. Women were equally likely to be coded for medical comorbidities during delivery hospitalization but significantly more likely to be coded for SMM during delivery of a stillbirth vs livebirth.

Primary and secondary outcomes are shown in Table 2 stratified by stillbirth vs livebirth and adjusted for SMM during delivery and maternal age, race/ethnicity, insurance type, income quartile by zip code, and medical comorbidities. After liveborn singleton delivery, 1.6% of women (n=19,746) presented to the Emergency Department (n=12,470) or were admitted to the hospital (n=7276) and were coded for psychiatric illness within 1 year of delivery. The risk of readmission or Emergency Department encounter with coding for psychiatric illness was nearly 2.5 times higher after stillbirth at ≥23 weeks gestation (n=331 [4.0%], with 146 inpatient admissions and 185 Emergency Department visits; adjusted odd ratio [aOR], 2.47; 95% confidence interval [CI], 2.20−2.77). Depression and anxiety were the most common psychiatric morbidities, and the risk was significantly higher after stillbirth vs livebirth for both conditions (aOR, 2.75 [95% CI, 2.31−3.26] for depression; aOR, 2.29 [95% CI, 1.93−2.70] for anxiety). Overall, with the exception of acute stress reaction, having a stillbirth was associated with significantly higher risk of presenting for each individual condition within the primary psychiatric outcome. Women also had higher risk of being coded for drug or alcohol use or dependence in an inpatient admission or Emergency Department encounter in the year after stillbirth than after livebirth (124 [1.5%] vs 7033 [0.6%]; aOR, 2.41 [95% CI, 1.99−2.90]).

**TABLE 1**
**Comparison of baseline characteristics among women with no coding for preexisting psychiatric illness in the 9 months before delivery of a stillborn singleton at ≥23 weeks gestation vs a liveborn singleton**

| Variable | Stillborn singleton ≥23 weeks gestation (n=8292), n (%) | Liveborn singleton (n=1,194,758), n (%) | Unadjusted odds ratio (95% confidence interval) |
|---|---|---|---|
| Maternal age at delivery, y | | | |
| < 18 | 390 (4.7) | 46,111 (3.9) | 1.29 (1.17–1.43) |
| 18–34 | 6354 (76.6) | 970,842 (81.3) | Reference |
| 35–39 | 1132 (13.7) | 140,478 (11.8) | 1.23 (1.16–1.31) |
| ≥40 | 416 (5.0) | 37,327 (3.1) | 1.70 (1.54–1.88) |
| Race/ethnicity[a] | | | |
| White | 3177 (38.9) | 602,944 (51.2) | Reference |
| Black | 3189 (39.0) | 258,213 (21.9) | 2.34 (2.23–2.46) |
| Latina | 1348 (16.5) | 239,967 (20.4) | 1.07 (1.00–1.14) |
| Other | 463 (5.6) | 77,145 (6.5) | 1.14 (1.03–1.26) |
| Insurance type | | | |
| Private Insurance | 3685 (44.4) | 580,882 (48.6) | Reference |
| Public Insurance | 4351 (52.5) | 577,724 (48.4) | 1.19 (1.14–1.24) |
| Other | 256 (3.1) | 36,152 (3.0) | 1.11 (0.98–1.26) |
| Income quartile, based on zip code[b] | | | |
| 1 (Poorest) | 2714 (38.9) | 313,859 (31.5) | 1.70 (1.55–1.86) |
| 2 | 2180 (31.3) | 305,680 (25.6) | 1.40 (1.28–1.54) |
| 3 | 1499 (21.5) | 262,221 (26.3) | 1.12 (1.02–1.24) |
| 4 (Wealthiest) | 578 (8.3) | 113,691 (11.4) | Reference |
| Mode of delivery | | | |
| Spontaneous vaginal | 6125 (77.9) | 691,122 (57.8) | Reference |
| Operative vaginal | 209 (2.7) | 54,889 (4.6) | 0.43 (0.37–0.49) |
| Cesarean | 1523 (19.4) | 448,747 (37.6) | 0.38 (0.36–0.41) |
| Maternal medical comorbidity composite[c] | 2463 (29.7) | 360,036 (30.1) | 0.98 (0.93–1.03) |
| Severe intrapartum morbidity composite[d] | 610 (7.4) | 15,530 (1.3) | 6.03 (5.54–6.56) |

[a] Missing data from 115 stillbirths and 16,489 livebirths; [b] Missing data from 1321 stillbirths and 199,310 livebirths; [c] As defined by validated maternal comorbidity index[20]; [d] As defined by the Centers for Disease Control's composite for severe maternal morbidity.[21]

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Cox proportional hazard ratios were used to examine the association between stillbirth and the primary outcome over the 12-month follow-up period. The proportional hazards assumption was violated for the 12-month (*P*=.007) and 6-month (*P*=.009) follow-up periods but not violated when follow up was limited to the first 4 months (*P*=.1) and months 4–12 after hospital discharge (*P*=.1). After adjusting for maternal age, race/ethnicity, insurance status, and income quartile by zip code, we found a statistically significant association between stillbirth compared with livebirth and the development of the primary outcome for both the first 4 months after hospital discharge (adjusted hazard ratio, 3.26; 95% CI, 2.6–4.04) and months 4–12 after hospital discharge (adjusted hazard ratio, 2.42; 95% CI, 2.13–2.76).

Table 3 shows the association between postpartum psychiatric morbidity and stillbirth when Emergency Department encounters were excluded as an outcome. Overall, the risk of being coded for the primary outcome during a postpartum inpatient hospitalization was nearly 3 times higher after a delivery of a stillbirth vs livebirth (n=146 ([1.8%] vs 7276 [0.6%]; aOR, 2.81; 95% CI, 2.37–3.33). The risk of being coded for posttraumatic stress disorder or adjustment disorder during an inpatient hospitalization within 1 year of stillbirth was >4 times higher than after livebirth (aOR, 5.36 [95% CI, 2.73–10.51] for posttraumatic stress disorder; aOR, 4.46 [95% CI, 2.86–6.94] for adjustment disorder). Women also had a higher risk of being coded for drug or alcohol use or dependence in an inpatient admission or Emergency Department encounter in the year after a stillbirth than a livebirth (63 [0.8%] vs 2931 [0.3%]; aOR, 2.80; 95% CI, 2.15–3.63).

Additional multivariable analyses tested whether significant interactions between independent variables existed in the primary outcome model. The probability values for interactions were not significant for race/ethnicity (*P*=.2), payer type (*P*=.40), mode of delivery (*P*=.7), or SMM (*P*=.4). However, the probability values for interaction were statistically significant for maternal comorbidities (*P*=.007) and income quartile by zip code (*P*<.0001). After we controlled the data for other factors, women who were coded during delivery hospitalization for at least 1 medical comorbidity had nearly twice the risk of postpartum psychiatric morbidity in the year after stillbirth compared with livebirth (aOR, 1.91; 95% CI, 1.66–2.21). Although those who were not coded for medical comorbidities during delivery were also more likely to have postpartum psychiatric morbidity after stillbirth compared with livebirth, the risk was comparatively lower (aOR, 1.63; 95%

TABLE 2
**Risk of psychiatric morbidity coded during an Emergency Department or hospitalization within 1 year of delivery of a stillborn singleton at ≥23 weeks gestation vs a liveborn singleton among women with no preexisting psychiatric conditions**

| Outcome | Stillborn singleton ≥23 weeks gestation (n=8292), n (%) | Liveborn singleton (n=1,194,758), n (%) | Unadjusted odds ratio for composite psychiatric morbidity (95% confidence interval) | Adjusted odds ratio for composite psychiatric morbidity (95% confidence interval)[a] |
|---|---|---|---|---|
| Composite psychiatric morbidity | 331 (4.0) | 19,746 (1.6) | 2.48 (2.22–2.78) | 2.47 (2.20–2.77) |
| Suicide attempt | 12 (0.1) | 559 (0.05) | 3.10 (1.75–5.49) | 3.16 (1.78–5.62) |
| Depression | 141 (1.7) | 7,726 (0.7) | 2.86 (2.25–3.24) | 2.75 (2.31–3.26) |
| Anxiety | 154 (1.9) | 9,809 (0.8) | 2.32 (1.92–2.68) | 2.29 (1.93–2.70) |
| Psychosis | 74 (0.9) | 4,672 (0.4) | 2.29 (1.82–2.89) | 2.27 (1.79–2.88) |
| Posttraumatic stress disorder[b] | — | 343 (0.03) | 4.21 (2.24–7.89) | 4.36 (2.31–8.24) |
| Acute stress reaction[b] | — | 636 (0.05) | 1.81 (0.90–3.64) | 1.66 (0.82–3.35) |
| Adjustment disorders | 31 (0.4) | 863 (0.07) | 5.19 (3.63–7.44) | 4.15 (2.83–6.09) |
| Composite substance use | 124 (1.5) | 7,033 (0.6) | 2.56 (2.14–3.07) | 2.41 (1.99–2.90) |
| Drug use and dependence | 99 (1.2) | 5,406 (0.5) | 2.66 (2.18–3.25) | 2.53 (2.05–3.11) |
| Alcohol use and dependence | 48 (0.6) | 2,381 (0.2) | 2.92 (2.19–3.88) | 2.69 (1.98–3.65) |

[a] Adjusted for maternal age, race/ethnicity, insurance type, income quartile by zip code, mode of delivery, severe intrapartum maternal morbidity, and medical comorbidities; [b] Unable to report (<11 women).

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CI, 1.43–1.85). Similarly, women in the lowest income quartile by zip code had an increased risk of postpartum psychiatric illness compared with those in the second lowest income quartile (aOR, 1.70 [95% CI, 1.45–2.01] vs aOR, 1.55 [95% CI, 1.29–1.87]).

Sensitivity analyses are shown in Appendix C. Extending the exclusion period for psychiatric morbidity or substance use from 9 months to 2 years before delivery hospitalization did not significantly change the primary or secondary outcome (aOR, 2.74; 95% CI, 2.39–3.13) for composite psychiatric morbidity, and aOR, 2.49 [95% CI, 1.98–3.13] for composite substance use; Appendix C1). Similarly, the association between stillbirth and postpartum psychiatric morbidity was similar after the exclusion of women who had SMM during delivery (Appendix C2), medical comorbidities (Appendix C3), or either SMM or medical comorbidities (Appendix C4; aOR, 2.53 [95% CI, 2.24–2.85] with the exclusion of SMM; aOR, 2.24 [95% CI, 1.93–2.61] with the exclusion of comorbidities; aOR, 2.21 [95% CI, 1.89–2.58] with the exclusion of SMM or comorbidities). Last, removing psychosis as a condition for exclusion and from the primary outcome composite did not significantly change the findings (aOR, 2.53; 95% CI, 2.24–2.84; Appendix C5).

## Comment

### Principal findings

In this large retrospective cohort study, we provide insight into the incidence of year-long postpartum psychiatric morbidity in women who delivered a stillbirth singleton at ≥23 weeks gestation or a liveborn singleton. In women who delivered livebirths, presentation to the Emergency Department or admission to the hospital for either acute psychiatric care or management of drug or alcohol use or dependence was not uncommon within 1 year of hospital discharge after delivery (1.6% and 0.6%, respectively). However, the risk was significantly higher after stillbirth; 4% of women who had a stillbirth at ≥23 weeks gestation (1 in every 25) had psychiatric diagnoses, and 1.5% (3 in 100) had substance use coded at an Emergency Department visit or inpatient hospitalization within 1 year of delivery. Of note, the risk of the primary postpartum psychiatric morbidity composite was higher in the first 4 months after stillbirth delivery (adjusted hazard ratio, 3.26; 95% CI, 2.63–4.04) than in the remainder of the year follow-up period. However, the risk remained >2 times higher during months 8–12 months after delivery and when women with ICD-9-CM codes for SMM or medical comorbidities during delivery hospitalization were excluded.

### Results

Our findings support previous studies that suggested that non-Hispanic black race and advanced maternal age are risk

**TABLE 3**
**Risk of severe psychiatric morbidity coded during inpatient hospitalization within 1 year of delivery of a stillbirth at ≥23 weeks gestation vs a liveborn singleton at ≥37 weeks gestation among women with no preexisting psychiatric conditions**

| | Psychiatric illness coded during inpatient hospitalization only[a] | | | |
|---|---|---|---|---|
| Outcome | Stillborn singleton at ≥23 weeks gestation (n=8292), n (%) | Liveborn singleton (n=1,194,758), n (%) | Unadjusted odds ratio for composite psychiatric morbidity (95% confidence interval) | Adjusted odds ratio for composite psychiatric morbidity (95% confidence interval)[b] |
| Composite psychiatric morbidity | 146 (1.8) | 7276 (0.6) | 2.93 (2.48–3.45) | 2.81 (2.37–3.33) |
| Suicide attempt | 0 (0.0) | 0 (0.0) | — | — |
| Depression | 64 (0.8) | 2921 (0.2) | 3.18 (2.48–4.07) | 3.05 (2.35–3.94) |
| Anxiety | 32 (0.4) | 1934 (0.2) | 2.39 (1.68–3.39) | 2.30 (1.59–3.31) |
| Psychosis | 56 (0.7) | 3196 (0.3) | 2.54 (1.95–3.31) | 2.50 (1.91–3.28) |
| Posttraumatic stress disorder[c] | — | 255 (0.02) | 5.09 (2.62–9.90) | 5.36 (2.73–10.51) |
| Acute stress reaction[c] | — | 90 (0.01) | 1.60 (0.22–11.49) | 1.45 (0.20–10.49) |
| Adjustment disorders | 22 (0.3) | 582 (0.05) | 5.19 (3.63–7.44) | 4.46 (2.86–6.94) |
| Composite substance use | 63 (0.8) | 2931 (0.3) | 3.11 (2.42–4.00) | 2.80 (2.15–3.63) |
| Drug use and dependence | 53 (0.6) | 2523 (0.2) | 2.66 (2.18–3.25) | 2.53 (2.05–3.11) |
| Alcohol use and dependence | 24 (0.3) | 794 (0.07) | 2.92 (2.19–3.88) | 2.69 (1.98–3.65) |

[a] Emergency Department visits excluded; [b] Adjusted for maternal age, race/ethnicity, insurance type, income quartile by zip code, mode of delivery, severe intrapartum maternal morbidity, and medical comorbidities; [c] Unable to report (<11 women).

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factors for stillbirth.[17] Current guidelines suggest that intrapartum morbidity is a risk factor for stillbirth mostly in developing countries,[17] but our findings suggest SMM may be a risk factor in developed countries, although our analyses cannot determine causality. We also identified additional risk factors for stillbirth, including public insurance compared with private insurance and lower socioeconomic status, as defined by being within lower income quartile by zip code compared with the highest income quartile. Of note, in our study population, women were equally likely to have medical comorbidities coded during delivery hospitalization for stillbirth vs livebirth, although conditions within the comorbidity composite such as diabetes mellitus, renal disease, and lupus have been associated with increased risk of stillbirth.[17] The disparity between our findings and clinical guidelines may reflect variations in coding accuracy or actual difference between the 2 groups and should be corroborated with prospective research.

To our knowledge, there have been no published studies that have analyzed the association between stillbirth and diagnosed postpartum psychiatric illness in a large US cohort. However, our findings have precedent. The association between stillbirth and self-reported depression, anxiety, and posttraumatic stress is clear.[10,11] Furthermore, our findings support previous database studies that used clinician-diagnosed psychiatric morbidity. Among Taiwanese women, having a stillbirth or abortion was associated with increased risk of attempted and completed suicide within 1 year of delivery, compared with having a livebirth.[16] Similarly, Danish women had increased risk of psychiatric hospital contact after a delivery that is associated with pregnancy loss (miscarriage or stillbirth).[15] In addition to supporting the literature, our findings allow us to examine the specific association between stillbirth and postpartum psychiatric morbidity.

## Clinical implications

In our study, postpartum psychiatric morbidity was not uncommon after delivery of a term, liveborn singleton, which aligns with recent data that have suggested that the stress of a "normal" vaginal delivery and "routine" postpartum care can be a powerful stimulant for psychiatric illness,[1,2] particularly postpartum depression and anxiety.[26] The association with stillbirth and psychiatric illness reinforces the growing body of literature that suggests that unanticipated obstetric events, such as unplanned cesarean delivery,[3] unintended pregnancy,[4] miscarriage,[5] and perception of negative or traumatic birth experience,[6] increase the risk of psychiatric morbidity above that of baseline.

Taken together, these findings support American College of Obstetricians and Gynecologists's recent recommendations to not only screen all women for depression and anxiety after delivery[26] but also to provide individualized care with additional in-person visits as needed for 3 months after delivery[28] and throughout the interpregnancy interval.[29] More specifically, we found that women who have stillbirth at ≥23 weeks gestation have an increased risk of postpartum psychiatric morbidity for 1 year after delivery but that this risk was highest in the first 4 months. These findings have important clinical and public-health ramifications for postpartum care in the United States; women with increased risk of stillbirth were not white, in the lowest income quartiles by zip code, and had public insurance, which often discontinues at 6 weeks after delivery. Thus, women at higher risk for stillbirth may be left without access to medical or psychiatric care during the highest risk time for acute psychiatric morbidity, which extends for months after their delivery.

## Strengths and limitations

Our study offers several strengths. First, our findings describe a clinical phenomenon (acute postpartum psychiatric illness in the year after delivery) that can help guide clinical practice. Second, our data derive from a large, comprehensive, all-payer database including nearly all in-patient admissions and Emergency Department presentations in Florida for nearly a decade. Third, we included postpartum outcomes until 1 year after the index delivery hospitalization in our analysis. Although some European administrative data studies include prolonged postpartum follow- up in their analyses,[2,23] previous North American database studies limited postpartum outcome assessment to ≤90 days.[30,31] Our extended timeline allows for the inclusion of maternal psychiatric morbidity in a postpartum period in line with American College of Obstetricians and Gynecologists's recent recommendations to provide individualized postpartum care beyond the traditional 6-week period.[28,29] Fourth, our primary analyses first included, then excluded, psychiatric morbidity codes during Emergency Department encounters as outcomes because a recent metaanalysis suggested that, compared with adults who are black, who have government insurance, or who are lower income, those who are white have private insurance and have higher income code are less likely to use Emergency Department services.[32] In our study, women with stillbirth were more likely to be black, have government insurance, and be lower income compared with those with livebirth. Excluding Emergency Department encounters as an outcome in our primary analyses allowed us to eliminate a potential confounder (Emergency Department visit use variation by demographic factors) within the association between stillbirth and postpartum psychiatric morbidity. Fifth, our ICD-9-CM coding has been validated for all critical variables that have been included in this analysis, including deliveries,[19] psychiatric morbidity,[2,22] drug and alcohol use and dependence,[24] maternal medical comorbidities,[20] and severe maternal morbidity.[20,21,33,34] This validation strengthens our findings.

Last, our study is strengthened by the multiple sensitivity analyses that tested the association between stillbirth and psychiatric illness by varying potential confounders. For example, despite the fact that nearly one-third of nonmaternal and nonneonatal hospitalizations in the United States in 2012 included primary or secondary diagnosis codes of metal or substance use disorders,[35] psychiatric and substance use diagnoses may be undercoded within HCUP.[36,37] Thus, we conducted a sensitivity analysis that extended the exclusion period for antepartum psychiatric or substance use morbidity from pregnancy (assumed to be 9 months) to 2 years before delivery to increase the likelihood that women with psychiatric morbidity were identified and excluded from our analyses. The association between SMM and postpartum psychiatric morbidity remained robust. In addition, to ensure that the presence of SMM or maternal comorbidities did not confound the association between stillbirth and postpartum psychiatric morbidity, we reanalyzed the primary and secondary outcome, excluding women with SMM, with medical comorbidities, or with either SMM or medical comorbidities. These exclusions did not impact our results significantly; women with no ICD-9-CM coding for SMM or medical comorbidities during delivery hospitalization have more than twice the risk of postpartum psychiatric morbidity in the year after stillbirth vs livebirth. Finally, although our primary outcome was modeled off of previously published psychiatric composites, the primary analyses included psychosis. Because psychosis is the only condition within the composite that was categorized as a psychotic disorder in the *Diagnostic and Statistical Manual of Mental Disorders, 5th Edition* (DSM-5),[27] we removed psychosis as both an exclusion for a preexisting psychiatric morbidity and as a condition within the primary composite outcome. The association did not change significantly.

Nevertheless, limitations should be considered. First, as with any retrospective study, causality cannot be established; we can describe only an association between stillbirth and postpartum psychiatric morbidity and recommend that these findings be confirmed with prospective data. Second, administrative database studies rely on ICD-9-CM procedure and diagnosis codes, and variations in coding practices among hospitals may have resulted in the undercoding or misclassification of conditions within our outcome.[38] This may confound our results.Third, although stillbirth is defined in the United States as pregnancy loss ≥20 weeks gestation,[17] our study defined stillbirth as ≥23 weeks gestation because of ICD-9-CM diagnosis code definitions. The lack of inclusion of stillbirth between 20 and 22 weeks decreased the absolute number of stillbirths that were included in our analyses; however, this omission likely had minimal impact on our study population, given that the absolute number of stillbirths that occur from 20−22 weeks is less, compared with

that of stillbirths at gestational ages included in our analyses.[17] Fourth, it is possible that providers were more likely to code for psychiatric comorbidities after stillbirth vs livebirth. This differential misclassification could have influenced our results in 2 ways; an increase in ICD-9-CM diagnosis codes for psychiatric morbidity during delivery hospitalization would have excluded proportionally more women with stillbirth than with livebirth in our analyses and would have resulted in a selection bias. Conversely, an increase in the coding of our primary or secondary outcomes during an Emergency Department visit or hospitalization after stillbirth would have skewed our results away from the null. It is unlikely that this differential misclassification would have rendered our findings statistically insignificant, but prospective research is needed to examine its impact on our results.

Finally, the HCUP database includes only inpatient admissions and Emergency Department visits that are associated with a hospital in Florida. Therefore, patients who moved out of Florida after their delivery would have been lost-to-follow up; women who sought care for psychiatric morbidity or substance use in other states were not included in our study outcomes. The lack of outpatient data potentially affects our results in 2 ways. First, women with preexisting psychiatric illness who were treated exclusively in the outpatient setting would not have been excluded in our analyses, despite their increased risk of postpartum psychiatric illness.[26] However, this exclusion likely resulted in nondifferential misclassification because stable psychiatric illness is not considered an independent risk factor for stillbirth.[17] Conversely, the lack of outpatient data means that we could not capture women who experienced new-onset postpartum psychiatric morbidity or drug or alcohol misuse who were treated entirely in the outpatient setting. Given that the majority of postpartum psychiatric morbidity is managed as outpatient,[26] it is likely our analyses significantly underestimated the prevalence of postpartum psychiatric morbidity. However, it is impossible to determine whether this underestimation biases our results toward or against the null. More research is needed in a validated database that combines inpatient and outpatient medical care to determine the true prevalence of postpartum psychiatric morbidity after stillbirth and livebirth.

## Conclusion

In conclusion, we found that coding for psychiatric illness and substance use in Emergency Department visits and inpatient hospitalizations within 1 year of delivery occurs in 1.6% and 0.6% of women who deliver liveborn singletons, respectively, but is significantly more common among women who deliver stillbirths at ≥23 weeks gestation (4.0% and 1.5%, respectively). The risk of postpartum psychiatric morbidity was nearly 2.5 times higher during the year after stillbirth vs livebirth delivery, and the highest risk period for acute psychiatric morbidity after stillbirth was identified as the first 4 months after delivery. These findings suggest that additional psychosocial support should be offered to all women in the year after delivery, particularly in the first 4 months after those with stillbirth, which would support previous studies[9,12,14,39] and the American College of Obstetricians and Gynecologists's current initiative to provide individualized postpartum care beyond the traditional 6-week visit.[28,29]

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## Appendix A

**TABLE A1**
**Diagnosis codes included for maternal comorbidities[20]**

| Medical condition of procedure | International Classification of Diseases, 9th Revision, Clinical Modification |
|---|---|
| Pulmonary hypertension | 416.0x, 416.8x, 416.9x |
| Sickle cell disease | 282.4x, 282.6x |
| Placenta previa | 641.0x, 641.1x |
| Gestational hypertension | 642.3x (with no preeclampsia/eclampsia or preexisting hypertension) |
| Mild or unspecified preeclampsia | 642.4x, 642.7x (with no severe preeclampsia/eclampsia) |
| Severe preeclampsia/eclampsia | 642.5x, 642.6x |
| Chronic renal disease | 581.x–583.x, 587.x, 588.x, 646.2x |
| Preexisting hypertension | 401.x–405.x, 642.0x–642.2x, 642.7x |
| Chronic ischemic heart disease | 412.x–414.x |
| Congenital heart disease | 745.0x–747.4x, 648.5x |
| Systemic lupus erythematosus | 710.0x |
| Human immunodeficiency virus | 042.x, V08.x |
| Cardiac valvular disease | 394.x–397.x, 424.x |
| Chronic congestive heart failure | 428.22, 428.23, 428.32, 428.33, 428.42, 428.43 |
| Asthma | 493.x |
| Preexisting diabetes mellitus | 250.x, 648.0x |
| Gestational diabetes mellitus | 648.x (with no preexisting diabetes mellitus) |
| Obesity | 278.0x, 649.1x, V85.3, V85.4 |
| Cystic fibrosis | 277.0x |
| Previous cesarean delivery | 654.2x |

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TABLE A2
**Diagnosis and procedure codes included in the severe maternal morbidity composite, as per the Centers for Disease Control and Prevention[21]**

| Medical condition of procedure | Diagnosis or procedure | International Classification of Diseases, 9th Revision, Clinical Modification |
|---|---|---|
| Acute myocardial infarction | Diagnosis | 410.xx |
| Aneurysm | Diagnosis | 441.xx |
| Acute renal failure | Diagnosis | 584.5, 584.6, 584.7, 584.8, 584.9, 669.3x |
| Adult respiratory distress syndrome | Diagnosis | 518.5x, 518.81, 518.82, 518.84, 799.1 |
| Amniotic fluid embolism | Diagnosis | 673.1x |
| Cardiac arrest/ventricular fibrillation | Diagnosis | 427.41, 427.42, 427.5 |
| Conversion of cardiac rhythm | Procedure | 99.6x |
| Disseminated intravascular coagulation | Diagnosis | 286.6, 286.9, 666.3x |
| Eclampsia | Diagnosis | 642.6x |
| Heart failure/arrest during surgery of procedure | Diagnosis | 997.1 |
| Puerperal cerebrovascular disorders | Diagnosis | 430.xx, 431.xx, 432.xx, 433.xx, 434.xx, 436.xx, 437.xx, 671.5x, 674.0x, 997.02 |
| Pulmonary edema/acute heart failure | Diagnosis | 518.4, 428.1, 428.0, 428.21, 428.23, 428.31, 428.33, 428.41, 428.43 |
| Severe anesthesia complications | Diagnosis | 668.0x, 668.1x, 668.2x |
| Sepsis | Diagnosis | 038.xx, 995.91, 995.92, 670.2x |
| Shock | Diagnosis | 669.1x, 785.5x, 995.0, 995.4, 998.0x |
| Sickle cell disease with crisis | Diagnosis | 282.42, 282.62, 282.64, 282.69 |
| Air and thrombotic embolism | Diagnosis | 415.1x, 673.0x, 673.2x, 673.2x, 673.3x, 673.8x |
| Blood transfusion | Procedure | 99.0x |
| Hysterectomy | Procedure | 68.3x–68.9x |
| Temporary tracheostomy | Procedure | 31.1 |
| Ventilation | Procedure | 93.90, 96.01, 96.02, 96.03, 96.05 |

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TABLE A3
**Diagnosis and procedure codes included in the psychiatric and substance use composite and to defined subsequent pregnancy**

| Medical condition of procedure | Diagnosis or procedure | International Classification of Diseases, 9th Revision, Clinical Modification |
|---|---|---|
| Psychiatric composite | | |
| Acute stress response | Diagnosis | 308.0–308.4, 308.9 |
| Adjustment disorder | Diagnosis | 309.0, 309.1, 309.24, 309.28, 309.4, 309.9 |
| Anxiety | Diagnosis | 300.00, 300.01, 300.02, 300.09 |
| Depression | Diagnosis | 300.4, 301.12, 311x |
| Posttraumatic stress disorder | Diagnosis | 309.81 |
| Psychosis | Diagnosis | 298.0–298.4, 298.0, 295.0–298.9, 299.10, 299.11 |
| Suicide attempt | Diagnosis (E-code) | E950, E951, E952, E953, E954, E955 |
| Substance abuse composite | | |
| Alcohol use, abuse, or dependence | Diagnosis | 291.9, 291.81, 291.82, 291.89, 291.0–291.5, 303.00–303.92 |
| Recreations drug use, abuse, or dependence | Diagnosis | 292.0, 292.11, 292.12, 292.2, 292.3, 292.81–282.89, 292.9, 304.00–304.92, 305.20–305.92 |
| Subsequent pregnancy codes | | |
| Pregnancy-related inpatient hospitalization codes | Diagnosis | 640–679 |
| Delivery | Diagnosis | 650, V270, V271 |

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APPENDIX B
**Comparison of preexisting psychiatric comorbidities among women who had a stillborn singleton at ≥23 weeks gestation vs liveborn singleton**

| Outcome | Stillborn singleton ≥23 weeks gestation (n=8812), n (%) | Liveborn singleton (n=1,230,650), n (%) | *P* value |
|---|---|---|---|
| Composite psychiatric morbidity | 447 (5.1) | 35,892 (2.9) | <.0001 |
| Suicide attempt[a] | — | 338 (0.03) | .004 |
| Depression | 215 (2.4) | 17,366 (1.4) | <.0001 |
| Anxiety | 118 (1.3) | 11,478 (0.9) | <.0001 |
| Psychosis | 123 (1.4) | 9,527 (0.8) | <.0001 |
| Posttraumatic stress disorder | 15 (0.2 ) | 690 (0.06) | <.0001 |
| Acute stress reaction[a] | — | 266 (0.02) | .03 |
| Adjustment disorders | 43 (0.5) | 946 (0.08) | <.0001 |
| Composite substance use | 316 (3.6) | 18,852 (1.5) | <.0001 |
| Drug use and dependence | 301 (3.4) | 18,097 (1.5) | <.0001 |
| Alcohol use and dependence | 46 (0.5) | 1,709 (0.1) | <.0001 |

[a] Unable to report (<11 women).

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# Appendix C1 Primary and secondary outcomes, excluding women who presented to the Emergency Department or hospital for psychiatric illness in the 2 years before delivery

**TABLE C1-1**
**Comparison of baseline characteristics among women who did not present to the Emergency Department or hospital for psychiatric illness in the 2 years before delivery of a stillborn singleton at ≥23 weeks gestation vs liveborn singleton**

| | Women who did not have psychiatric morbidity 2 years before delivery | | |
|---|---|---|---|
| Variable | Stillborn singleton ≥23 weeks gestation (n=5783), n (%) | Liveborn singleton (n=816,048), n (%) | *P* value |
| Maternal age at delivery, y | | | <.0001 |
| <18 | 259 (4.5) | 31,933 (3.9) | |
| 18–34 | 4453 (77.0) | 661,942 (81.1) | |
| 35–39 | 760 (13.1) | 95,535 (11.7) | |
| ≥40 | 311 (5.4) | 26,638 (3.3) | |
| Race/ethnicity[a] | | | <.0001 |
| White | 2181 (38.3) | 402,349 (50.1) | |
| Black | 2221 (39.0) | 176,319 (21.9) | |
| Latina | 971 (17.0) | 168,337 (20.9) | |
| Other | 324 (0.57) | 57,322 (7.1) | |
| Insurance type | | | <.0001 |
| Private | 2552 (44.1) | 390,058 (47.8) | |
| Public | 3044 (52.6) | 400,281 (49.1) | |
| Other | 187 (3.3) | 25,709 (3.1) | |
| Income quartile, based on zip code[b] | | | <.0001 |
| 1 (Poorest) | 2213 (38.7) | 254,293 (31.5) | |
| 2 | 1806 (31.6) | 248,158 (30.4) | |
| 3 | 1251 (21.9) | 214,888 (26.6) | |
| 4 (Wealthiest) | 447 (7.8) | 89,738 (11.1) | |
| Mode of delivery | | | <.0001 |
| Spontaneous vaginal | 4310 (78.5) | 465,143 (57.0) | |
| Operative vaginal | 145 (2.6) | 38,058 (4.7) | |
| Cesarean | 1035 (18.9) | 312,847 (38.3) | |
| Maternal medical comorbidity composite[c] | 1711 (29.6) | 243,684 (29.7) | |
| Severe intrapartum morbidity composite[d] | 440 (7.6) | 11,469 (1.4) | <.0001 |

[a] Missing data from 86 stillbirths and 11,721 livebirths; [b] Missing data from 66 stillbirths and 8971 livebirths; [c] As defined by validated maternal comorbidity index[20]; [d] As defined by the Centers for Disease Control's composite for severe maternal morbidity.[21]

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TABLE C1-2

**Risk of psychiatric morbidity coded during an Emergency Department or hospitalization within 1 year of delivery of a stillborn singleton at ≥23 weeks gestation vs a liveborn singleton among women who did not have diagnosis codes for psychiatric illness in the 2 years before delivery hospitalization**

| | Outcomes among women who did not have psychiatric morbidity 2 years before delivery | | |
|---|---|---|---|
| Outcome | Stillborn singleton ≥23 weeks gestation (n=5783), n (%) | Liveborn singleton (n=816,048), n (%) | Adjusted odds ratio for composite psychiatric morbidity (95% confidence interval)[a] |
| Composite psychiatric morbidity | 240 (4.2) | 12,895 (1.6) | 2.74 (2.39–3.13) |
| Suicide attempt[b] | — | 338 (0.04) | 3.68 (1.89–7.17) |
| Depression | 99 (1.7) | 4,939 (0.6) | 3.00 (2.45–3.69) |
| Anxiety | 121 (2.1) | 6,750 (0.8) | 2.61 (2.16–3.15) |
| Psychosis | 43 (0.7) | 2,842 (0.4) | 2.18 (1.60–2.96) |
| Posttraumatic stress disorder[b] | — | 244 (0.03) | 4.23 (1.98–9.04) |
| Acute stress reaction[b] | — | 407 (0.05) | 2.17 (1.02–4.61) |
| Adjustment disorders | 24 (0.4) | 518 (0.06) | 5.30 (3.43–8.19) |
| Composite substance use | 84 (1.5) | 4,561 (0.6) | 2.49 (1.98–3.13) |
| Drug use and dependence | 62 (1.1) | 3,449 (0.4) | 2.51 (1.93–3.25) |
| Alcohol use and dependence | 31 (0.5) | 1,544 (0.2) | 2.53 (1.72–3.72) |

[a] Adjusted for maternal age, race/ethnicity, insurance type, income quartile by zip code, mode of delivery, severe intrapartum maternal morbidity, and medical comorbidities; [b] Unable to report (<11 women).

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## Appendix C2 Primary and secondary outcomes, with the exclusion of women who had an International Classification of Diseases, 9th Revision, Clinical Modification code that indicated severe intrapartum maternal morbidity during delivery (Appendix A)[21]

**TABLE C2-1**
**Comparison of baseline characteristics among women with no psychiatric morbidity during pregnancy or severe intrapartum maternal morbidity during delivery who had a stillborn singleton ≥ 23 weeks gestation vs liveborn singleton**

| | Women with no severe intrapartum maternal morbidity | | |
|---|---|---|---|
| Variable | Stillborn singleton ≥23 weeks gestation (n=7682), n (%) | Liveborn singleton (n=1,179,228), n (%) | *P* value |
| Maternal age at delivery, y | | | <.0001 |
| <18 | 363 (4.7) | 45,387 (3.9) | |
| 18–34 | 5891 (76.7) | 959,047 (81.3) | |
| 35–39 | 1045 (13.6) | 138,259 (11.7) | |
| ≥40 | 383 (5.0) | 36,535 (3.1) | |
| Race/ethnicity[a] | | | <.0001 |
| White | 2983 (39.3) | 596,621 (51.3) | |
| Black | 2875 (37.9) | 253,146 (21.8) | |
| Latina | 1278 (16.9) | 237,023 (20.4) | |
| Other | 439 (5.8) | 76,162 (6.5) | |
| Insurance type | | | <.0001 |
| Private | 3454 (45.0) | 574,236 (48.7) | |
| Public | 3989 (51.9) | 569,359 (48.3) | |
| Other | 239 (3.1) | 35,633 (3.0) | |
| Income quartile, based on zip code[b] | | | <.0001 |
| 1 (Poorest) | 2502 (38.8) | 309,028 (31.5) | |
| 2 | 2008 (31.2) | 301,500 (30.7) | |
| 3 | 1394 (21.6) | 259,072 (26.4) | |
| 4 (Wealthiest) | 541 (8.4) | 112,406 (11.4) | |
| Mode of delivery | | | <.0001 |
| Spontaneous vaginal | 5853 (80.3) | 686,417 (58.2) | |
| Operative vaginal | 198 (2.7) | 54,258 (4.6) | |
| Cesarean | 1241 (17.0) | 438,553 (37.2) | |
| Maternal medical comorbidity composite[c] | 2150 (28.0) | 351,251 (29.8) | .0006 |

[a] Missing data from 107 stillbirths and 16,276 livebirths; [b] Missing data from 1237 stillbirths and 197,222 livebirths; [c] As defined by validated maternal comorbidity index.[20]

*Lewkowitz et al. Stillbirth and psychiatric illness. Am J Obstet Gynecol 2019.*

TABLE C2-2
**Risk of psychiatric morbidity coded during an Emergency Department or hospitalization within 1 year of delivery of a stillborn singleton at ≥23 weeks gestation vs a liveborn singleton among women with no preexisting psychiatric conditions and with no severe intrapartum maternal morbidity**

| | Women with no severe intrapartum maternal morbidity | | |
|---|---|---|---|
| Outcome | Stillborn singleton ≥23 weeks gestation (n=7682), n (%) | Liveborn singleton (n=1,179,228), n (%) | Adjusted odds ratio for composite psychiatric morbidity (95% confidence interval)[a] |
| Composite psychiatric morbidity | 296 (3.9) | 19,294 (1.6) | 2.53 (2.24–2.85) |
| Suicide attempt | 11 (0.1) | 554 (0.05) | 3.07 (1.68–5.58) |
| Depression | 126 (1.6) | 7,540 (0.6) | 2.82 (2.35–3.38) |
| Anxiety | 136 (1.8) | 9,679 (0.8) | 2.33 (1.95–2.78) |
| Psychosis | 69 (0.9) | 4,577 (0.4) | 2.41 (1.89–3.07) |
| Posttraumatic stress disorder[b] | — | 332 (0.03) | 4.67 (2.40–9.08) |
| Acute stress reaction[b] | — | 622 (0.05) | 1.43 (0.64–3.19) |
| Adjustment disorders | 26 (0.3) | 829 (0.07) | 4.22 (2.78–6.40) |
| Composite substance use | 111 (1.4) | 6,863 (0.6) | 2.52 (2.07–3.07) |
| Drug use and dependence | 89 (1.2) | 5,268 (0.5) | 2.70 (2.17–3.35) |
| Alcohol use and dependence | 42 (0.6) | 2,331 (0.2) | 2.71 (1.96–3.74) |

[a] Adjusted for maternal age, race/ethnicity, insurance type, income quartile by zip code, mode of delivery, and medical comorbidities; [b] Unable to report (<11 women).

*Lewkowitz et al. Stillbirth and psychiatric illness. Am J Obstet Gynecol 2019.*

# Appendix C3 Primary and secondary outcomes, with the exclusion of women who had an International Classification of Diseases, 9th Revision, Clinical Modification code that indicated maternal medical comorbidity during delivery hospitalization (Appendix A)[20]

**TABLE C3-1**
**Comparison of baseline characteristics among women with no coding for medical comorbidities during delivery hospitalization or preexisting psychiatric illness in the 9 months before delivery of a stillborn singleton at ≥23 weeks gestation vs a liveborn singleton**

| | Women with no medical comorbidities coded during delivery hospitalization | | |
|---|---|---|---|
| Variable | Stillborn infant ≥23 weeks gestation (n=5829), n (%) | Liveborn singleton (n=834,722), n (%) | *P* value |
| Maternal age at delivery, y | | | <.0001 |
| <18 | 336 (5.8) | 37,903 (4.5) | |
| 18–34 | 4586 (78.7) | 697,184 (83.5) | |
| 35–39 | 666 (11.4) | 80,688 (9.7) | |
| ≥40 | 241 (4.1) | 18,947 (2.3) | |
| Race/ethnicity[a] | | | <.0001 |
| White | 2301 (41.8) | 428,580 (52.1) | |
| Black | 2140 (38.9) | 173,559 (21.1) | |
| Latina | 979 (17.8) | 166,290 (20.2) | |
| Other | 322 (5.8) | 54,327 (6.6) | |
| Insurance type | | | <.0001 |
| Private | 2607 (44.7) | 400,733 (48.0) | |
| Public | 3057 (52.4) | 408,408 (48.9) | |
| Other | 165 (2.8) | 25,581 (3.1) | |
| Income quartile, based on zip code[b] | | | <.0001 |
| 1 (Poorest) | 1842 (37.7) | 218,509 (31.4) | |
| 2 | 1561 (31.9) | 214,241 (30.8) | |
| 3 | 1074 (18.4) | 183,981 (26.4) | |
| 4 (Wealthiest) | 417 (7.2) | 79,379 (11.4) | |
| Mode of delivery | | | <.0001 |
| Spontaneous vaginal | 4710 (85.8) | 570,278 (68.3) | |
| Operative vaginal | 143 (2.6) | 219,305 (26.3) | |
| Cesarean | 636 (11.6) | 45,139 (5.4) | |
| Severe intrapartum morbidity composite[c] | 297 (5.1) | 6745 (0.8) | <.0001 |

[a] Missing data from 87 stillbirths and 11,966 livebirths; [b] Missing data from 935 stillbirths and 138,612 livebirths; [c] As defined by the Centers for Disease Control's composite for severe maternal morbidity.[21]

*Lewkowitz et al. Stillbirth and psychiatric illness. Am J Obstet Gynecol 2019.*

TABLE C3-2
**Risk of psychiatric morbidity coded during an Emergency Department or hospitalization within 1 year of delivery of a stillborn singleton at ≥23 weeks gestation vs a liveborn singleton among women with no preexisting psychiatric conditions or maternal comorbidities**

| | Outcomes among women with no medical comorbidities coded during delivery hospitalization | | |
|---|---|---|---|
| Outcome | Stillborn infant ≥23 weeks gestation (n=5829), n (%) | Liveborn singleton (n=834,722), n (%) | Adjusted odds ratio for composite psychiatric morbidity (95% confidence interval)[a] |
| Composite psychiatric morbidity | 194 (3.3) | 12,836 (1.5) | 2.24 (1.93–2.61) |
| Suicide attempt[b] | — | 389 (0.05) | 3.28 (1.69–6.38) |
| Depression | 81 (1.4) | 4,994 (0.6) | 2.49 (1.99–3.12) |
| Anxiety | 95 (1.6) | 6,252 (0.8) | 2.23 (1.80–2.76) |
| Psychosis | 45 (0.8) | 3,171 (0.4) | 2.03 (1.50–2.75) |
| Posttraumatic stress disorder[b] | — | 227 (0.03) | 3.88 (1.71–8.80) |
| Acute stress reaction[b] | — | 422 (0.05) | 1.00 (0.32–3.12) |
| Adjustment disorders | 19 (0.3) | 593 (0.07) | 3.85 (2.37–6.27) |
| Composite substance use | 82 (1.4) | 4,963 (0.6) | 2.27 (1.80–2.86) |
| Drug use and dependence | 64 (1.1) | 3,783 (0.5) | 2.36 (1.82–3.06) |
| Alcohol use and dependence | 33 (0.6) | 1,706 (0.2) | 2.55 (1.76–3.69) |

[a] Adjusted for maternal age, race/ethnicity, insurance type, income quartile by zip code, mode of delivery, and severe intrapartum maternal morbidity; [b] Unable to report (<11 women).
*Lewkowitz et al. Stillbirth and psychiatric illness. Am J Obstet Gynecol 2019.*

## Appendix C4 Primary and secondary outcomes, with the exclusion of women who had an International Classification of Diseases, 9th Revision, Clinical Modification code that indicated maternal medical comorbidities[20] or severe intrapartum maternal morbidity during delivery[21] (Appendix A)

**TABLE C4-1**
**Comparison of baseline characteristics among women with no coding for comorbidities or severe intrapartum maternal morbidity during delivery hospitalization or preexisting psychiatric illness in the 9 months before delivery of a stillborn singleton at ≥23 weeks gestation vs a liveborn singleton**

| | Women with no medical comorbidities or severe intrapartum maternal morbidities | | |
|---|---|---|---|
| Variable | Stillborn infant ≥23 weeks gestation (n=5532), n (%) | Liveborn singleton (n=827,977), n (%) | *P* value |
| Maternal age at delivery, y | | | |
| <18 | 323 (5.8) | 37,530 (4.5) | <.0001 |
| 18–34 | 4353 (78.7) | 691,815 (83.6) | |
| 35–39 | 628 (11.4) | 79,927 (9.6) | |
| ≥40 | 228 (4.1) | 18,705 (2.3) | |
| Race/ethnicity[a] | | | |
| White | 2199 (40.3) | 425,598 (52.0) | <.0001 |
| Black | 1998 (36.7) | 171,701 (21.0) | |
| Latina | 941 (17.3) | 53,855 (6.6) | |
| Other | 310 (5.7) | 11,868 (1.4) | |
| Insurance type | | | |
| Private | 2490 (45.0) | 397,837 (48.0) | <.0001 |
| Public | 2881 (52.1) | 404,787 (48.9) | |
| Other | 161 (2.9) | 25,353 (3.1) | |
| Income quartile, based on zip code[b] | | | |
| 1 (Poorest) | 1744 (37.6) | 216,426 (31.4) | <.0001 |
| 2 | 1467 (31.6) | 212,425 (30.8) | |
| 3 | 1031 (22.2) | 182,576 (26.4) | |
| 4 (Wealthiest) | 401 (8.6) | 78,782 (11.4) | |
| Mode of delivery | | | |
| Spontaneous vaginal | 4555 (87.3) | 567,290 (68.5) | <.0001 |
| Operative vaginal | 137 (2.6) | 44,733 (5.4) | |
| Cesarean | 528 (10.1) | 215,954 (26.1) | |

[a] Missing data from 84 stillbirths and 11,868 livebirths; [b] Missing data from 889 stillbirths and 137,768 livebirths.

*Lewkowitz et al. Stillbirth and psychiatric illness. Am J Obstet Gynecol 2019.*

TABLE C4-2

**Risk of psychiatric morbidity coded during an Emergency Department or hospitalization within 1 year of delivery of a stillborn singleton at ≥23 weeks gestation vs a liveborn singleton among women with no preexisting psychiatric conditions, severe intrapartum maternal morbidity, or medical comorbidities**

| | Outcomes among women with no medical comorbidities or severe intrapartum maternal morbidities | | |
|---|---|---|---|
| Outcome | Stillborn infant ≥23 weeks gestation (n=5532), n (%) | Liveborn singleton (n=827,977), n (%) | Adjusted odds ratio for composite psychiatric morbidity (95% confidence interval)[a] |
| Composite psychiatric morbidity | 175 (3.2) | 12,672 (1.5) | 2.21 (1.89–2.58) |
| Suicide attempt[b] | — | 386 (0.05) | 3.08 (1.53–6.22) |
| Depression | 72 (1.3) | 4,926 (0.6) | 2.41 (1.90–3.06) |
| Anxiety | 86 (1.6) | 6,173 (0.8) | 2.22 (1.78–2.78) |
| Psychosis | 41 (0.8) | 3,127 (0.4) | 2.06 (1.50–1.81) |
| Posttraumatic stress disorder[b] | — | 222 (0.03) | 3.73 (1.53–9.07) |
| Acute stress reaction[b] | — | 420 (0.05) | 0.69 (0.17–2.79) |
| Adjustment disorders | 17 (0.3) | 581 (0.07) | 3.83 (2.29–6.42) |
| Composite substance use | 73 (1.3) | 4,890 (0.6) | 2.26 (1.78–2.89) |
| Drug use and dependence | 58 (1.1) | 3,723 (0.5) | 2.44 (1.87–3.19) |
| Alcohol use and dependence | 29 (0.5) | 1,685 (0.2) | 2.49 (1.69–3.68) |

[a] Adjusted for maternal age, race/ethnicity, insurance type, income quartile by zip code, and mode of delivery; [b] Unable to report (<11 women).

*Lewkowitz et al. Stillbirth and psychiatric illness. Am J Obstet Gynecol 2019.*

# Appendix C5 Primary and secondary outcomes, with the exclusion of psychosis as a condition within the psychiatric morbidity composite and as an exclusion for preexisting psychiatric condition

TABLE C5-1
**Comparison of baseline characteristics among women with no psychiatric morbidity during pregnancy who delivered a stillborn at ≥23 weeks gestation vs liveborn singleton**

| Variable | Exclusion of psychosis as a condition within psychiatric morbidity composite and as exclusion for preexisting psychiatric condition | | |
|---|---|---|---|
| | Stillborn infant ≥23 weeks gestation (n=8376), n (%) | Liveborn singleton (n=1,202,029), n (%) | *P* value |
| Maternal age at delivery, y | | | <.0001 |
| <18 | 392 (4.7) | 46,568 (3.9) | |
| 18–34 | 6416 (76.6) | 976,676 (81.3) | |
| 35–39 | 1150 (13.7) | 141,222 (11.8) | |
| ≥40 | 418 (5.0) | 37,563 (3.1) | |
| Race/ethnicity[a] | | | <.0001 |
| White | 3221 (39.0) | 607,863 (51.3) | |
| Black | 3217 (38.9) | 259,546 (21.9) | |
| Latina | 1356 (16.4) | 240,698 (20.3) | |
| Other | 467 (5.7) | 77,373 (6.5) | |
| Insurance type | | | <.0001 |
| Private | 3699 (44.2) | 582,355 (48.5) | |
| Public | 4416 (52.7) | 583,269 (48.5) | |
| Other | 261 (3.1) | 36,405 (3.0) | |
| Income quartile, based on zip code[b] | | | <.0001 |
| 1 (Poorest) | 2749 (39.0) | 316,320 (31.6) | |
| 2 | 2203 (26.3) | 307,724 (30.7) | |
| 3 | 1508 (21.4) | 363,682 (26.3) | |
| 4 (Wealthiest) | 582 (8.3) | 114,093 (11.4) | |
| Mode of delivery | | | <.0001 |
| Spontaneous vaginal | 6176 (77.8) | 695,195 (57.8) | |
| Operative vaginal | 214 (2.7) | 55,169 (4.6) | |
| Cesarean | 1550 (19.5) | 451,665 (37.6) | |
| Severe intrapartum morbidity[c] | 621 (7.4) | 15,700 (1.3) | <.0001 |
| Maternal medical comorbidity composite[d] | 2509 (30.0) | 363,108 (30.2) | .6 |

[a] Missing data from 115 stillbirths and 16,559 livebirths; [b] Missing data from 1334 stillbirths and 200,210 livebirths; [c] As defined by validated maternal comorbidity index[20]; [d] As defined by the Centers for Disease Control's composite for severe maternal morbidity.[21]

*Lewkowitz et al. Stillbirth and psychiatric illness. Am J Obstet Gynecol 2019.*

TABLE C5-2
**Risk of psychiatric morbidity coded during an Emergency Department or hospitalization within 1 year of delivery of a stillbirth at ≥23 weeks gestation vs a liveborn singleton among women with no preexisting psychiatric conditions**

| Outcome | Exclusion of psychosis as condition within psychiatric morbidity composite and as exclusion for preexisting psychiatric condition | | |
|---|---|---|---|
| | Stillborn infant ≥23 weeks gestation (n=8376), n (%) | Liveborn singleton (n=1,202,029), n (%) | Adjusted odds ratio for composite psychiatric morbidity (95% confidence interval)[a] |
| Composite psychiatric morbidity[b] | 312 (3.7) | 18,111 (1.5) | 2.53 (2.24–2.84) |
| Suicide attempt | 12 (0.1) | 596 (0.05) | 2.97 (1.67–5.27) |
| Depression | 152 (1.8) | 8,287 (0.7) | 2.73 (2.31–3.22) |
| Anxiety | 165 (2.0) | 10,293 (0.9) | 2.34 (1.99–2.74) |
| Posttraumatic stress disorder[c] | 12 (0.1) | 410 (0.03) | 4.46 (2.49–7.97) |
| Acute stress reaction[c] | — | 662 (0.06) | 1.60 (0.79–3.22) |
| Adjustment disorders | 32 (0.4) | 896 (0.07) | 4.14 (2.84–6.03) |
| Composite substance use | 135 (1.6) | 7,643 (0.6) | 2.40 (2.00–2.87) |
| Drug use and dependence | 110 (1.3) | 5,946 (0.5) | 2.54 (2.08–3.09) |
| Alcohol use and dependence | 50 (0.6) | 2,570 (0.2) | 2.56 (1.90–3.44) |

[a] Adjusted for maternal age, race/ethnicity, insurance type, income quartile by zip code, mode of delivery, medical comorbidities, and severe intrapartum maternal morbidity; [b] Includes suicide attempt, depression, anxiety, posttraumatic stress disorder, acute stress reaction, or adjustment disorders; psychosis excluded; [c] Unable to report (<11 women).

*Lewkowitz et al. Stillbirth and psychiatric illness. Am J Obstet Gynecol 2019.*