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Social Determinants of Health and Risk of Stillbirth in the United States

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Abstract

Objective Our aim was to evaluate the impact of social determinants of health (SDoH) risk factors on stillbirth among pregnancy-related hospitalizations in the United States.

Study Design We conducted a cross-sectional analysis of delivery-related hospital discharges using annualized data (2016–2017) from the Healthcare Cost and Utilization Project's Nationwide Inpatient Sample. The International Classification of Diseases, 10th Revision ICD-10-CM codes were used to select women with singleton stillbirth. Z-codes were utilized to identify SDoH risk factors and their subtypes. The association between SDoH risk factors and stillbirth was assessed using survey logistic regression models.

Results We analyzed 8,148,646 hospitalizations, out of which 91,140 were related to stillbirth hospitalizations, yielding a stillbirth incidence of 1.1%. An increased incidence was observed for non-Hispanic (NH) Blacks (1.7%) when compared with NH Whites (1.0%). The incidence of stillbirth was greater in hospitalizations associated with SDoH risk factors compared with those without risk factors [2.0% vs. 1.1% (p <0.001)]. Among patients with SDoH risk factors, the rate of stillbirth was highest in those designated as NH other (3.0%). Mothers that presented with SDoH risk factors had a 60% greater risk of stillbirth compared with those without (odds ratio [OR] = 1.61 [95% confidence interval (CI) = 1.33–1.95], $p < 0.001$). The SDoH issues that showed the most significant risk for stillbirth were: occupational risk (OR = 7.05 [95% CI: 3.54–9.58], $p < 0.001$), upbringing (OR = 1.87 [95% CI: 1.23–2.82], $p < 0.001$), and primary support group and family (OR = 5.45 [95% 3.84–7.76], $p < 0.001$).

Conclusion We found pregnancies bearing SDoH risk factors to be associated with a 60% elevated risk for stillbirth. Future studies should target a variety of risk reduction strategies aimed at modifiable SDoH risk factors that can be widely implemented at both the population health level as well as in the direct clinical setting.

Keywords
- stillbirth
- health disparities
- social determinants of health
- ethnic disparities

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Key Points

- Health disparities exist in stillbirth rates, especially among NH Black women.
- Social determinants of health risk factors increase the risk of stillbirth.
- There is a need for further study on the impact of specific SDoH risk factors on stillbirth risk.

Intrauterine fetal demise or stillbirth, is defined in the United States as fetal death at ≥20 weeks' gestation, and complicates approximately one in 160 pregnancies or approximately 23,000 stillbirths annually.[1,2] While stillbirth is significantly more common in low to middle-income countries, the stillbirth rate in the United States remains higher than many other developed nations.[3] Improvements in prenatal care led to a sharp decline in stillbirth rates during the mid-20th century, but have since remained stagnant.[2,4] Numerous maternal and fetal factors have been previously identified as contributing to stillbirth.[1,5,6] Recent studies have shed light on the association between social determinants of health (SDoH) and stillbirth. It has been shown that certain SDoH (income, education, health care access, and air pollution) are associated with higher rates of stillbirth.[7–11] SDoH are conditions in the environments in which people are born, live, learn, work, play, worship, and age that affect a wide range of health, functioning, and quality-of-life outcomes and risks.[12] Five key areas include: economic stability, education access and quality, social and community context, health care access and quality and neighborhood, and built environment.[12] Among nonmodifiable risk factors for stillbirth, non-Hispanic (NH) Black race remains one of the most prevalent and persistent.[13,14] Among NH Black women in the United States, the rate of stillbirth is more than twice that of other racial groups.[1,2,] Reasons for this disparity have been attributed to clustering of maternal and fetal risk factors in NH Black women, but when these factors are not present, the disparity in stillbirth rates remains.[5,15,16] Understanding and improving these conditions could enhance health outcomes and reduce racial and ethnic disparities in stillbirth.[17]

There is a paucity of literature examining the association of SDoH with stillbirth in the United States. Additionally prior studies have been limited by sample size and types of SDoH factors evaluated.[11,15] Available evidence does show a significant association between factors such as gender equality (as measured by contraceptive access and maternal education) and poverty with stillbirth, as well as improvement in stillbirth rates, observed in racially integrated communities.[10,18–20] Nonetheless, more research in this area is greatly needed. The aim of this study was to evaluate the impact of SDoH risk factors on stillbirth among pregnancy-related hospitalizations in a large U.S. population.

Materials and Methods

We conducted a cross-sectional analysis of delivery-related hospital discharges using the 2016 to 2017 annual data from the Healthcare Cost and Utilization Project's (HCUP) Nationwide Inpatient Sample (NIS). The NIS is a large, all-payer, publicly available inpatient database in the United States (*https://www.hcup-us.ahrq.gov/db/nation/nis/nisdbdocumentation.jsp*). The NIS dataset is created using a sampling technique that stratifies all nonfederal community hospitals from participating states into groups based on five major hospital characteristics as follows: (1) rural/urban location, (2) number of beds, (3) geographic region, (4) teaching status, and (5) ownership. HCUP performs quality control of diagnostic and procedural codes to minimize coding errors within the database and maintain a valid and consistent dataset (*https://www.hcup-us.ahrq.gov/db/quality.jsp#editcheck2015*). A 20% sample of hospitals was randomly drawn from each stratum, and all inpatient discharges from the selected hospitals were included. The NIS database comprises hospital stratum identifiers and discharge-level sampling weights that can be used to generate national estimates.

Each hospital discharge record contains International Classification of Diseases, 10th Revision, Clinical Modification (ICD-10-CM) codes for a patient's principal diagnosis and up to 29 secondary diagnoses. Delivery-related admissions were classified as maternal and/or neonatal based on the presence of ICD-10-CM diagnosis codes (►Table 1). Z-codes were utilized to characterize SDoH risk factors and their subtypes which were the exposure variables in this research. The outcome of interest for this study was characterized using ICD-10-CM to select women with singleton stillbirth (►Table 1).

To explore differences in baseline characteristics, we compared the distribution of selected sociodemographic and hospital characteristics of delivery-related discharges among those who experienced stillbirth to those who did not. We grouped maternal age in years into three categories as follows: (1) 15 to 24 years, (2) 25 to 34 years, and (3) 35 to 49 years. Race/ethnicity classification was first determined by ethnicity (Hispanic or NH); with the NH group further subdivided by race (White, Black, or other). Due to small numbers, the category of other is a combination of the following groups: Asian or Pacific Islander, Native American, mixed race, and other. Median household income quartile was estimated by HCUP using the zip code of residence on the mother's delivery record and zip code–demographic data. Primary payers for each hospital stay were classified into Medicare, Medicaid, private, self-pay and others. Hospital characteristics were assessed based on their teaching status (teaching vs. nonteaching), location (urban vs. rural), and U.S. geographic region (Northeast, Midwest, South, or West). Hospital bed size was categorized as small, medium, large, or missing using U.S. regions, the urban–rural designation of the hospital, and teaching

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Table 1 ICD-10 codes for social determinants of health

Details	ICD-10 codes
Maternal conditions and complications	A34, C58, D392, F53, M830, Ox, Z037x, Z3201, Z34x, Z35x, Z36x, Z37x, Z39x, Z3Ax
Intrauterine fetal demise	O364x, Z8759x, P95,Z371
Any SDoH issue	Z55x, Z56x, Z57x, Z59x, Z60x, Z62x, Z63x, Z64x, Z65
Problems related to education and literacy	Z55x
Problems related to employment and unemployment	Z56x
Occupational exposure to risk factors	Z57x
Problems related to housing and economic circumstances	Z59x
Problems related to social environment	Z60x
Problems related to upbringing	Z62x
Other problems related to primary support group, including family circumstances	Z63x
Problems related to psychosocial circumstances	Z64x, Z65x

Abbreviations: ICD-10, International Classification of Disease, 10th Revision; SDoH, social determinants of health.

status. Rural hospitals were not split based on teaching status for bed size categorization purpose, because rural teaching hospitals were rare.

All statistical analyses were performed using R version 3.5.1 (University of Auckland, Auckland, New Zealand), R Studio Version 1.1.4.2.3 (Boston, MA). We performed descriptive analyses to evaluate the relationship between patient characteristics and stillbirth. Bivariate analyses using Pearson's Chi-square test were conducted to determine the association between each of the SDoH subtypes and the frequency of stillbirth. Next, we calculated the rates of stillbirth among mothers who experienced SDoH risk factors, stratified by race/ethnicity. Using adjusted survey logistic regression model, we generated odds ratios to quantify the association between SDoH risk factors and stillbirth after adjusting for patient and hospital characteristics. Lastly, the risk of stillbirth was calculated for each SDoH subtype after adjusting for hospitalization characteristics. Since the primary outcome of the study, stillbirth, is a rare event, the adjusted odd ratios approximate the relative risks.

All hypothesis tests were two-tailed with type-I error set at 5%. Since the study was performed using deidentified publicly available data, the institutional review board at Baylor College of Medicine classified this study as exempt.

Results

Our study included a total of 8,148,646 hospitalizations of which 91,140 were related to stillbirth hospitalizations yielding a stillbirth incidence of 1.1%.The total number of stillbirths and incidence stratified by patient characteristics are presented in ►Table 2.

Results of our analysis for stillbirth incidence by SDoH risk factors are displayed on ►Table 3. The incidence of stillbirth among cases with any SDoH risk factor was 2.0% compared with 1.1% in cases without SDoH risk factors ($p < 0.001$). Among specific SDoH risk factors, the highest incidence estimates were related to problems associated with education and literacy (2.9%), occupational risk (16.7%), housing and economic circumstances (1.7%), upbringing (2.1%), and primary support group, including family circumstances (6.0%).

Of the total study population, 29,445 (1%) of patients had at least one SDoH risk factor. Racial stratification of patients with SDoH risk factors was as follows: NH White = 12,535 (42.6%), NH Black = 7,330 (24.9%), Hispanic = 5,635 (19.1%), NH other = 2,330 (7.9%), and 1,615 (5.5%) had missing race/ethnicity data. Among patients with SDoH risk factor, the highest rates of stillbirth were observed in those identifying as NH other (3.0%) or Hispanic (2.1%) (►Fig. 1).

The results of the evaluation for the association between SDoH risk factor and patient characteristics and risk of stillbirth are summarized in ►Table 4. Mothers that presented with SDoH risk factors had an approximately 60% greater risk of stillbirth compared with those without (odds ratio [OR] = 1.61 [95% confidence interval (CI) = 1.33–1.95], $p < 0.001$). Our results showed notable racial/ethnic disparities after adjustment for other characteristics as outlined in ►Table 4. Compared with NH Whites, NH Blacks experienced more than 50% greater risk for stillbirth (OR = 1.54 [95% CI = 1.46–1.62], $p < 0.001$), while Hispanic mothers exhibited a slightly lower likelihood for stillbirth (OR = 0.94 [95% CI = 0.88–0.99], $p = 0.03$).

The age groups of 25–34 (OR = 1.17 [95% CI = 1.13–1.22], $p < 0.001$) and 35–49 (OR = 1.60 [95%CI = 1.52–1.68], $p < 0.001$) years also showed elevated risk of stillbirth when compared with the age group <24 years.

The adjusted odds of stillbirth declined progressively with increasing income quartile in a dose–response pattern reaching a nadir for mothers in the highest income quartile. Health insurance status and hospital region of hospitalization were also predictive of risk for stillbirth. Mothers who self-paid for hospital services had the greatest risk of stillbirth, while those on private insurance experienced the

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Table 2 Patient characteristics by stillbirth status

	Stillbirth				
	No *n* (%)		Yes *n* (%)		Incidence (%)
	N = 8,057,506	% = 100	*N* = 91,140	% = 100	
Age (y)					
15–24	2,080,752	25.8	21,235	23.3	1.0
25–34	4,587,105	56.9	50,075	54.9	1.1
35–49	1,389,649	17.2	19,830	21.8	1.4
Race/ethnicity					
NH White	3,968,510	49.3	40,215	44.1	1.0
NH Black	1,205,270	15.0	20,515	22.5	1.7
Hispanic	1,580,833	19.6	15,580	17.1	1.0
NH other	881,794	10.9	8,265	9.1	0.9
Missing	421,099	5.2	6,565	7.2	1.5
Discharge status					
Routine	7,876,411	97.8	89,225	97.9	1.1
Transfer	42,425	0.5	650	0.7	1.5
Died	805	0.0	85	0.1	9.6
Discharged against medical advice	25,760	0.3	490	0.5	1.9
Other	108,160	1.3	675	0.7	0.6
Missing	3,945	0.0	15	0.0	0.4
Zip income quartile					
Lowest quartile	2,311,128	28.7	29,495	32.4	1.3
2nd quartile	2,002,508	24.9	23,490	25.8	1.2
3rd quartile	1,950,823	24.2	20,815	22.8	1.1
Highest quartile	1,713,318	21.3	16,420	18.0	0.9
Missing	79,730	1.0	920	1.0	1.1
Primary payer					
Medicare	67,450	0.8	1,025	1.1	1.5
Medicaid	3,528,246	43.8	42,440	46.6	1.2
Private insurance	4,018,131	49.9	41,345	45.4	1.0
Self-pay	433,289	5.4	6,130	6.7	1.4
Missing	10,390	0.1	200	0.2	1.9
Hospital characteristics					
Hospital region					
Northeast	1,292,875	16.0	13,230	14.5	1.0
Midwest	1,688,008	20.9	20,160	22.1	1.2
South	3,139,333	39.0	38,655	42.4	1.2
West	1,937,291	24.0	19,095	21.0	1.0
Hospital bed size					
Small	1,439,653	17.9	14,875	16.3	1.0
Medium	2,470,709	30.7	25,840	28.4	1.0
Large	4,147,144	51.5	50,425	55.3	1.2
Hospital location and teaching status					
Rural	735,562	9.1	8,355	9.2	1.1
Urban nonteaching	1,870,371	23.2	18,410	20.2	1.0
Urban teaching	5,451,573	67.7	64,375	70.6	1.2

Note: Definitions of variable can be found at the following address: *https://www.hcupus.ahrq.gov/db/nation/nis/nisdbdocumentation.jsp*.

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Table 3 Prevalence of social determinants of health[a,b]

	Stillbirth					*P*-Value
	No *n* (%)		Yes *n* (%)		Incidence	
	N = 8,057,506	*C*% = 100	*N* = 91,140	*C*% = 100		
Any SDoH issue						
No	8,028,651	99.6	90,550	99.4	1.1	<0.001
Yes	28,855	0.4	590	0.6	2.0	
Problems related to education and literacy						
No	8,057,341	100.0	91,135	100.0	1.1	0.02
Yes	165	0.0	"–"	0.0	2.9	
Problems related to employment and unemployment						
No	8,055,501	100.0	91,110	100.0	1.1	0.127
Yes	2,005	0.0	30	0.0	1.5	
Occupational exposure to risk factors						
No	8,057,481	100.0	91,135	100.0	1.1	<0.001
Yes	25	0.0	"–"	0.0	16.7	
Problems related to housing and economic circumstances						
No	8,046,391	99.9	90,945	99.8	1.1	<0.001
Yes	11,115	0.1	195	0.2	1.7	
Problems related to social environment						
No	8,055,821	100.0	91,125	100.0	1.1	0.335
Yes	1,685	0.0	15	0.0	0.9	
Problems related to upbringing						
No	8,051,306	99.9	91,010	99.9	1.1	<0.001
Yes	6,200	0.1	130	0.1	2.1	
Other problems related to primary support group, including family circumstances						
No	8,054,601	100.0	90,955	99.8	1.1	<0.001
Yes	2,905	0.0	185	0.2	6.0	
Problems related to psychosocial circumstances						
No	8,050,666	99.9	91,070	99.9	1.1	0.404
Yes	6,840	0.1	70	0.1	1.0	

Abbreviations: SDoH, social determinants of health.
[a]Based on ICD-10-CM/PCS: International Classification of Diseases, 10th Revision, Clinical Modification/Procedure Coding System.
[b]Counts containing a value of 10 or less were suppressed to ensure confidentiality of patients, these values are noted as "–."

lowest risk. Compared with health facilities in the Northeast, those located in the South exhibited a 14% (OR = 1.14 [95% CI = 1.03–1.27], $p = 0.01$) greater likelihood of stillbirth occurrence, while health facilities in the Midwest and the West did not show stillbirth risk elevation. The risk of stillbirth was also significantly increased with hospitalizations in large compared with small hospitals. However, rural or urban location of the health facility did not influence the risk of stillbirth.

Certain SDoH risk factors showed a stronger association with stillbirth than others (►Table 5). The SDoH risk factors that displayed the strongest linkage to stillbirth were problems related to occupational risks, (OR = 7.05 [95%CI = 3.54–9.58], $p < 0.001$), issues of upbringing, (OR = 1.87 [95% CI = 1.23–2.82], $p < 0.001$), and primary support group, including family circumstances (OR = 5.45 [95% CI = 3.84–7.76], $p < 0.001$).

Discussion

Stillbirth is one of the most common adverse pregnancy outcomes and has a profound impact on women and their families.[21,22] Recent studies have shed light on the association between SDoH and stillbirth.[7–12] Although the rate of stillbirth in the United States has been stable, significant racial/ethnic disparities persist.[2,23] Understanding the causes of these disparities can provide insight into opportunities to reduce stillbirth rates. Data presented here supports these prior findings and demonstrates the incidence of stillbirth among cases with any SDoH risk factor to be greater than in those without SDoH risk factors (2.0 vs. 1.1%; $p < 0.001$). SDoH

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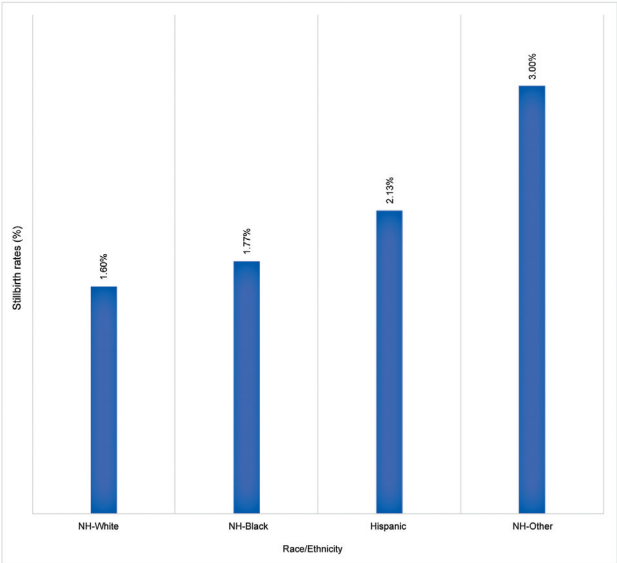

Fig. 1 Rates of stillbirth by race/ethnicity among pregnant women with SDOH risk factors. NH, non-Hispanic; SDoH, social determinants of health.

issues are associated with a 60% increased risk of stillbirth and 1% of our study population had at least one risk factor present. The rate of stillbirth when SDoH issues were present was highest among those identified as NH other (3.0%) or Hispanic (2.1%). The reasons for this are not clear but may be impacted by factors such as access and quality of health care or associated medical comorbidities in these populations.[2,9,24,25] Additionally factors such as the impact of immigration status cannot be assessed using these generalized categories. For example, it has been shown that more favorable birth outcomes are typically observed among Hispanic immigrants, but this same advantage is not consistently seen in U.S. born Hispanic individuals.[9]

When examining the impact of individual SDoH risk factors, most striking was a seven-fold increased risk of stillbirth when occupational exposures were present, a nearly two-fold increased risk when problems with upbringing were present, and a more than five-fold increased stillbirth risk associated with problems related to primary support groups. Additionally, there is likely an additive effect with the presence of more than one SDoH factor, which is supportive of prior evidence suggesting that multiple issues relating to interpersonal or environmental stressors increase risk of stillbirth in a dose-dependent manner.[26]

Additionally, results presented here support prior studies showing the association between stillbirth and environmental factors in both geography and facility type where care was received. We demonstrate a 14% greater likelihood of stillbirth in health care facilities in the South, consistent with prior data showing a disproportionately higher incidence of stillbirth compared with other regions.[10,27] Proposed explanations of this increased incidence of stillbirth in the southern United States include historical exposure to racial segregation, higher rates of poverty, and higher ambient temperatures by which heat exposure and dehydration

Table 4 Independent association between SDoH risk factors and patient characteristics (exposure) and the likelihood of stillbirth (outcome)

	OR (95% CI)	*P*-Value
Any SDoH issues		
No	Reference	<0.001
Yes	1.61 (1.33–1.95)	
Race/ethnicity		
NH White	Reference	
NH Black	1.54 (1.46–1.62)	<0.001
Hispanic	0.94 (0.88–0.99)	0.03
NH other	0.92 (0.86–0.97)	<0.001
Age (y)		
< 24	Reference	
25–34	1.17 (1.13–1.22)	<0.001
35–49	1.60 (1.52–1.68)	<0.001
Discharge status		
Routine	Reference	
Transfer	1.30 (1.09–1.55)	<0.001
Died	7.61 (4.56–12.68)	<0.001
Discharged against medical advice	1.42 (1.15–1.75)	<0.001
Other	0.52 (0.43–0.64)	<0.001
Zip income quartile		
Lowest quartile	Reference	
2nd quartile	0.99 (0.94–1.04)	0.62
3rd quartile	0.91 (0.86–0.97)	<0.001
Highest quartile	0.83 (0.76–0.91)	<0.001
Primary payer		
Private Insurance	Reference	
Medicare	1.24 (1.07–1.43)	<0.001
Medicaid	1.13 (1.09–1.18)	<0.001
Self-pay	1.37 (1.27–1.47)	<0.001
Hospital characteristics		
Hospital region		
Northeast	Reference	
Midwest	1.11 (0.98–1.26)	0.09
South	1.14 (1.03–1.27)	0.01
West	0.98 (0.88–1.09)	0.69
Hospital bed size		
Small	Reference	
Medium	1.02 (0.94–1.11)	0.67
Large	1.18 (1.08–1.30)	<0.001
Hospital location and teaching status		
Rural		
Urban nonteaching	0.93 (0.85–1.02)	0.12
Urban teaching	1.09 (0.99–1.19)	0.09

Abbreviations: CI, confidence interval; NH, non-Hispanic; OR, odds ratio; SDoH, social determinants of health.

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Table 5 Association between subtypes of SDoH and stillbirth

Group	OR	Lower CI	Upper CI	*p*-Value
Any SDoH issue	1.60	1.37	2.00	<0.001
Problems related to education and literacy	2.43	0.31	4.62	0.4
Problems related to employment and unemployment	1.21	0.53	2.76	0.64
Occupational exposure to risk factors	7.05	3.54	9.58	<0.001
Problems related to housing and economic circumstances	1.34	0.97	1.85	0.08
Problems related to social environment	0.74	0.25	2.20	0.59
Problems related to upbringing	1.87	1.23	2.82	<0.001
Other problems related to primary support group, including family circumstances	5.46	3.84	7.76	<0.001
Problems related to psychosocial circumstances	0.84	0.48	1.45	0.52

Abbreviations: CI, confidence interval; OR, odds ratio; SDoH, social determinants of health.

result in placental compromise, all of which have been previously shown to be associated with increased rates of stillbirth.[10,12,19,28]

We also show an association between stillbirth and maternal transfers. Transfers of care are high risk by nature and are more likely to end up at tertiary care center. Complex maternal medical comorbidities, high-risk obstetric conditions, and complex fetal disorders require multidisciplinary subspecialty care typically only available in large referral centers with the resources to care for both mother and fetus. Examples of such conditions include poorly controlled maternal hypertension or diabetes, pre-existing maternal cardiac or renal disease, hemolysis, elevated liver enzymes, low platelets (HELLP) syndrome, placenta accreta spectrum disorders, complex fetal anomalies, maternal trauma, and pregnancies affected by acute respiratory failure secondary to viral infection, such as seen during the current COVID-19 pandemic. These conditions create higher acuity due to their associated complications, such as hemorrhage, disseminated intravascular coagulopathy, stroke, organ failure, and cardiac arrest, any of which carry an associated higher risk of antepartum or intrapartum fetal death in addition to higher risk of maternal death.[1,8]

NH Black race has consistently been identified as a nonmodifiable risk factor for stillbirth and it has also been associated with increased risk for stillbirth recurrence in subsequent pregnancies.[9,29,30] In our study we have shown that NH Black race is associated with the highest incidence of stillbirth at 1.7%. Interestingly, unlike the other racial/ethnic groups in our study which showed a clear increase in stillbirth rates in the presence of SDoH issues, NH Black patients had similar stillbirth rates with and without the presence of SDoH issues. After adjusting for SDoH issues NH Black patients had a 54% higher risk of stillbirth when compared with NH White patients. Reasons for the increased rate of stillbirth in the NH Black population are likely numerous and compounding. These may range from disparities occurring at the individual level, such as poverty and access to care, to population-level inequities including effects of racial segregation relating to housing and employment.[22] Delays in seeking, initiating, and provision of adequate health care are also associated with adverse maternal outcomes, and NH Black women are likely to be impacted by all three types of delay.[25,31,32] Another study showed that communities with decreasing levels of segregation decreased the rate of stillbirth among NH Black women, suggesting that reducing structural racism can improve health outcomes.[10,19,33] Recognizing the complex interaction of social determinants in the lives of pregnant women of minority status, and, specifically, NH Black women, may be crucial to an improved understanding of disparities in pregnancy outcomes.

Strengths and Limitations

This study has several strengths. This is an adequately powered study, using a large database representing a diverse patient population from multiple settings across the United States, which makes our study results generalizable across many populations. Additionally, the methodology employed here using Z-codes to examine SDoH risk factors as it relates to stillbirth is novel. Use of Z-codes was introduced with the adoption of ICD-10 in 2015 and widespread uptake has been slow.[34] Given this, it is likely that the relationship between stillbirth and presence of SDoH risk factors presented here is an underestimation of their association.

There are some limitations to this study given that it is an observational study and cannot imply causality. Use of a large national database, while beneficial for generating a large and diverse sample size, analyses could be unduly influenced by missing or incomplete data. This is particularly true when examining race data which are often limited to broad predetermined categories and binary selection of race or ethnicity, and excludes biracial or multiracial participants and/or forces inaccurate labeling. Furthermore, since our data only includes information on hospitalized patients and not those presenting to outpatient settings and emergency rooms, the incidence of stillbirth in our study is higher than the general population since hospitalized patients may have other comorbidities or may have been admitted due to other causes such as accidents, which would have increased their risk of stillbirth. SDoH factors are only identified using ICD-10 coding and not from patient demographic characteristics such as patients' educational background, environmental, or occupational factors impacting their health, etc., and

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there is a possibility that not all SDoH factors were enlisted in patients' discharge records. There are also inherent limitations in using ICD-10 coded definitions for SDoH, given that we may not be capturing more nuanced issues, such as health care access and quality. Use of ICD-10 codes, particularly Z-codes, is subjected to the biases of the individual performing the coding. In addition, it has been shown that SDoH Z-codes are utilized more often in larger, private not-for-profit, and urban teaching hospitals, whereas the utilization in pregnant population is unknown. This could have resulted in biases due to underreporting and may undermine the actual burden of social needs experienced by hospitalized pregnant patients.[34] Additionally, these codes are not pregnancy specific. We are also unable to analyze associated factors that may influence the risk of stillbirth such as parity, fetal, and obstetric comorbidities; gestational age; and prior history of stillbirth.

Conclusion

To the best of the authors' knowledge, this study is the first population-level analysis examining specifically SDoH and stillbirth in a developed nation. Prior examinations in the areas of stillbirth and social determinants either differ in scope of analysis, are limited to smaller populations, or fail to examine other determinants outside race or ethnicity. These data highlight the need for further detailed study on the impact of specific SDoH risk factors on stillbirth risk, as well as the interplay between race and SDoH. Future studies should target a variety of risk reduction strategies aimed at modifiable SDoH risk markers that can be widely implemented at both the population health level, as well as in the direct clinical setting. Emphasis on the use of a multidisciplinary health care model incorporating clinical case management and social work specialists into routine care may help to identify and intervene on at-risk patients.

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Conflict of Interest

None declared.

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