Population Based Cohort Study of Fetal Deaths, and Neonatal and Perinatal Mortality at Term Within a Somali Diaspora

Stephen Contag (scontag@umn.edu)
University of Minnesota

Rahel Nardos
University of Minnesota

Irina Buhimschi
University of Illinois at Chicago

Jennifer Almanza
University of Minnesota

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Abstract

Background: Delivery among Somali women occurs later, we have no information on the associated perinatal mortality. Our objective is to compare perinatal mortality among Somali women with the population rates.

Methods: This is a retrospective cohort study 2011-2017. Information was obtained from certificates of birth, neonatal and fetal death through data use agreement signed between the Minnesota Department of Health and the University of Minnesota. Data derived from 470,550 non-anomalous births >20 weeks of gestation in Minnesota 2011-2017. We included all U.S. born White, U.S. born Black, women born in Somalia or self-identified as Somali, and women who identified as Hispanic regardless of place of birth (377,426), and excluded births <37 weeks and >42 weeks, > 1 fetus, age <18 or >45 years, or women of other ethnicities.

The exposure was documented ethnicity or place of birth, and the outcomes were live birth, fetal death, neonatal death prior to 28 days, and perinatal mortality rates. These were calculated using binomial proportions with 95% confidence intervals and compared using odds ratios (aOR) adjusted for diabetes, hypertension and maternal body mass index.

Results: The aOR for fetal and neonatal death in the Somali cohort was greater than for U.S. born White (aOR, 2.05 [95%CI: 1.49 - 2.83], aOR 1.84 [95%CI: 1.36 - 2.48]) and Hispanic women (aOR, 1.90 [95%CI: 1.30 - 2.79] and 1.47 [95%CI: 1.05 - 2.06] respectively). Limiting the analysis to those with spontaneous onset of labor (SOL) did not modify the results. This effect persisted up to 41 weeks after which the risk was similar to that of U.S. born White women but lower than for U.S. born Black women and Hispanic women.

Conclusions: Despite greater mean gestational age, Somali fetal death rates are similar to population rates. Neonatal mortality is increased compared with White women, but similar to that of other minorities in Minnesota. Somali neonatal mortality decreased and was comparable to that of the White population after 41 weeks.

Key Points:

Question: How does the greater median gestational age at delivery within the Somali diaspora impact perinatal mortality?

Findings: Perinatal mortality is increased mostly due to neonatal mortality, compared with US born White women, but comparable to that of other minorities. After 41 weeks, it is comparable to U.S. born White women.

Meaning: Perinatal mortality is similar among minorities mostly due to neonatal outcomes rather than differences in fetal death rates. After 41 weeks, Somali newborns have outcomes similar those of U.S.

born White women. This suggests that cultural and environmental resources may play a pivotal role in modifying outcomes.

Introduction:

Current epidemiological evidence shows that Somali women in the United States (U.S.) have lower rates of preterm birth. They also carry their pregnancies to later gestational ages with a modal distribution of gestational age at delivery that is one week delayed compared with U.S. born white women [1] and a higher rate of deliveries after 42 weeks [2]. A similar effect has been demonstrated for other Somali diaspora around the world. A cross-sectional population-based study of approximately 430,000 singleton births in Victoria, Australia comparing mothers born in East African countries relative to Australian-born women demonstrated that as a group, East Africans had increased odds of small for gestational age births, very low birthweight and very preterm birth, yet decreased odds of preterm birth [3]. This was mostly due to decreased risk among Somali women, who had lower preterm birth rates compared with other East African and Australian women [3].

Conversely, studies also show that immigrant women of African origin in Europe have the worst maternal and perinatal outcomes compared with a non-immigrant population [4]. Johnson et. al. 2005 reported that maternal morbidity is increased among Somali immigrants in Washington State with cesarean delivery most often secondary to fetal distress and failed induction of labor. In their cohort, post term delivery rates and oligohydramnios were significantly increased compared with U.S. born White or Black women [2]. This is associated with lower 5-minute Apgar scores, increased neonatal morbidity, assisted ventilation, meconium aspiration and prolonged hospitalization [2]. The mortality rate among babies born to immigrant women is not consistently higher in all countries, but in the U.S., it appears to be greater among immigrant Black women, including those from Somalia [3,5,6].

In a recent large epidemiologic study from Ohio that included almost 2,000,000 births from 2000–2015, rates of post term delivery after 42 weeks were increased fivefold among Somali women compared with all other ethnicities including African born women from West Africa [1]. This trend was maintained even after controlling for spontaneous or induced labor, smoking and parity [1]. It is not clear if this is associated with the observed increased perinatal morbidity and mortality reported for all immigrant Black women [7].

This situation is further complicated because Somali women will more often wait for spontaneous onset of labor (SOL) past 41 weeks before undergoing induction of labor (IOL) [2]. It has been demonstrated that active management of pregnancies complicated with either maternal or neonatal comorbidities benefit from recommendations for early term or delivery by 39 weeks [8,9]. Elective delivery by 39 weeks for low risk women also results in lower rates of cesarean delivery, preeclampsia and neonatal morbidity [10,11]. It is not clear whether this preference to delay delivery and waiting for SOL is associated with increased perinatal morbidity and mortality in the Somali diaspora resident in Minnesota.

Our hypothesis is that fetal, neonatal and perinatal mortality among Somali women is increased compared with other racial or ethnic groups in Minnesota secondary to an increased rate of deliveries after 40 weeks of gestation.

Methods:

This retrospective, large cohort study was performed with data obtained from linking live birth certificates with fetal death certificates for all births in the State of Minnesota between January 1, 2011 and December 31, 2017. Data was provided by a data use agreement between the Minnesota Department of Health and the University of Minnesota, and after obtaining Institutional Review Board (IRB) exemption from the University of Minnesota (IRB submission 00004909). The data agreement included all non-anomalous singleton births occurring at greater than 20 weeks between January 1, 2011 and December 31, 2017, to women who were residing in Minnesota during those years.

To address our hypothesis, the specific study aims were to compare the mean gestational age at delivery after SOL within the four largest ethnic and racial groups residing in the state based on commonly used categories used by the Centers for Disease Control and Prevention (CDC) [12]. These are: U.S. born white women, U.S. born Black women, Somali women and women of Hispanic ethnicity. We also compared the primary outcomes including fetal, neonatal and perinatal death rates at term, between the four ethnic groups, from 2011 to 2017. This is a population-based cohort, and sample size was not calculated. Due to the small number of cases with missing data, we did not make any assumptions. The only variable that was not reliably reported in all groups was the maternal body mass index and including or excluding it as a confounder did not modify the results.

Inclusion criteria were singleton term pregnancies without any known genetic or congenital anomaly, between 37 and 42 weeks of gestation dated by best obstetrical estimate. We included all pregnancies of women who had either SOL or IOL. Exclusion criteria were women whose age was less than 18 or greater than 45 at time of delivery as these groups have been shown to have an associated increase in perinatal morbidity and mortality [13–15] and women who did not identify as belonging to one of the four ethnicities included in our study cohort. We also excluded women who delivered before 37 weeks or after 42 weeks of gestation. Delivery < 37 weeks is considered a preterm delivery and management of pregnancy > 42 weeks is not within our standard of care. This allowed us to analyze pregnancies delivered within the period defined as term [16]. We also excluded pregnancies with more than one fetus.

Descriptive characteristics for the groups included were compared using chi-square or analysis of variance (ANOVA) as indicated by either continuous or categorical data. The birth rates after SOL per week were determined using binomial proportions with 95% confidence intervals between 37 and 42 weeks for all 4 ethnic-racial groups. We calculated the weekly fetal death rates, cumulative fetal death rates (risk of fetal death among all ongoing pregnancies), weekly neonatal death rates prior to 28 days of life, and perinatal mortality rates per 10,000 births using binomial proportions with 95% confidence intervals [17]. The risk for fetal and neonatal death regardless of whether labor was spontaneous or

induced was calculated for all four groups. A secondary analysis that only included women who delivered after SOL was performed to calculate risk for neonatal mortality but not for fetal death, as most fetal deaths are delivered after induction of labor and are not intrapartum events [18]. The methodology to classify women having SOL from birth certificates has been previously validated and published [19]. The odd ratio and adjusted odds ratio for the primary outcomes was calculated between the various groups using the Somali population as a reference group and adjusting for clinically relevant factors available in the birth or fetal death certificates: body mass index (BMI), pregestational diabetes, pregestational hypertension, gestational diabetes and gestational hypertension. Birthweight was used to adjust odds ratios for neonatal death but not for fetal death as this information is not reliably reported among stillborn fetuses and is not readily available unless a livebirth has occurred. We analyzed the data using SAS/STAT® software 9.4 (Cary, NC) using a logit model, and applying a dichotomous outcome variable of fetal or neonatal death. The log odds of the outcome was modeled as a linear combination of the predictor variables included. All figures were created with GraphPad Prizm (GraphPad Prism version 8.0.0 for Windows, GraphPad Software, San Diego, California U.S.A, www.graphpad.com). This manuscript adhered to “Strengthening the Reporting of Observational Studies” (STROBE) guidelines for reporting cohort studies [20].

Results:

Records for 470,550 births of non-anomalous infants born in the State of Minnesota were provided for analysis. We excluded 16,479 births of pregnancies with more than 1 fetus, 33,383 records of deliveries that occurred prior to 37 or after 42 weeks, 13,526 for maternal age < 18 or > 45 years, and 29,744 records from women who did not identify as belonging to one of the ethnicities in the study cohort. Information for 377,426 births and for 226,823 births after SOL were available for analysis. The mode for gestational age at delivery is 40 weeks for Somali women compared with 39 weeks for the rest of the population (Fig. 1). Perinatal mortality was higher compared with the U.S. born White population. However, compared with Hispanic and U.S. born Black women, perinatal mortality was higher between 37 and 40 weeks but lower after 41 weeks (Fig. 2).

We analyzed the births per year and observed a significant trend for decreasing numbers of births among U.S. born White women while rates among U.S. born Black, Somali and Hispanic women were rising, with the second highest proportion observed among Hispanic women (supplemental Table 1).

When comparing the descriptive characteristics among ethnicities, Somali women tended to have a lower level of education and higher parity. Together with Hispanic women, Somali women had a higher frequency of gestational diabetes; however, they also had the lowest incidence of hypertensive disease of pregnancy (Table 1). Regarding delivery characteristics, Somali and Hispanic women had the highest frequency of delivering after SOL. Although the highest frequency of vaginal delivery was observed among Hispanic women, both Somali and Hispanic women had the lowest primary cesarean delivery rates, with Somali women having the highest repeat cesarean delivery rates. Birthweight among Somali

newborns was lower than that observed for U.S. born White women but higher than that observed for U.S. born Black and Hispanic women (Table 2).

Table 1
Maternal descriptive characteristics of study population: singleton term deliveries in Minnesota 2011–2017

	Ethnicity/Birthplace n (%)				
Maternal variables	**U.S. White**	**U.S. Black**	**Somali**	**Hispanic**	**Total**
Age (years) [a]					
18–25	63060 (21.1)	10402 (51.9)	2333 (17.3)	18599 (41.1)	94394 (25.0)
26–35	201024 (67.3)	8334 (41.6)	9194 (68.1)	22370 (49.5)	240922 (63.8)
36–45	34581 (11.6)	1290 (6.4)	1976 (14.6)	4263 (9.4)	42110 (11.2)
Total	298665	20026	13503	45232	377426
Frequency Missing = 0					
BMI Category (kg/m2) [a]					
Underweight	5784 (2.1)	420 (2.3)	443 (3.54)	846 (2.0)	7493 (2.1)
Normal	132312 (47.0)	5718 (31.2)	4353 (34.8)	14724 (35.5)	157107 (44.4)
Overweight	75093 (26.7)	4816 (26.3)	4339 (34.7)	12978 (31.3)	97226 (27.5)
Obese	68142 (24.2)	7375 (40.2)	3387 (27.1)	12918 (31.2)	91822 (26.0)
Total	281331	18329	12522	41466	353648
Frequency Missing = 23778					
Education [a]					
<HS	11255 (3.8)	3484 (17.4)	7049 (52.2)	15064 (33.3)	36852 (9.8)
HS	40922 (13.7)	6447 (32.2)	3232 (23.9)	12692 (28.1)	63293 (16.8)
College or Graduate	199329 (66.7)	9440 (47.1)	3111 (23.0)	15649 (34.6)	227529 (60.3)
Post Graduate	47140 (15.8)	651 (3.3)	107 (0.8)	1820 (4.0)	49718 (13.2)
Unknown	19 (0.01)	4 (0.02)	4 (0.03)	7 (0.02)	34 (0.01)

	Ethnicity/Birthplace n (%)				
Total	298665	20026	13503	45232	377426
Parity [a]					
Nulliparous	118245 (39.7)	6849 (34.3)	2230 (16.6)	13513 (30.0)	140837 (37.4)
Parous	179453 (60.3)	13116 (65.7)	11215 (83.4)	31570 (70.0)	235354 (62.6)
Total	297698	19965	13445	45083	376191
Frequency Missing = 1235					
Diabetes [a]					
No DM	281101 (94.1)	18730 (93.5)	12189 (90.3)	40476 (89.5)	352496 (93.4)
PGD	1624 (0.5)	201 (1.0)	142 (1.1)	578 (1.3)	2545 (0.7)
GDM	15938 (5.3)	1095 (5.5)	1172 (8.7)	4177 (9.2)	22382 (5.9)
Total	298663	20026	13503	45231	377423
Frequency Missing = 3					
Hypertension [a]					
No HTN	280109 (93.8)	18204 (90.9)	13047 (96.6)	42937 (94.9)	354297 (93.9)
CHTN	2890 (1.0)	517 (2.6)	56 (0.4)	417 (0.9)	3880 (1.0)
GHTN	15662 (5.2)	1305 (6.5)	400 (3.0)	1878 (4.2)	19245 (5.1)
Total	298661	20026	13503	45232	377422
Frequency Missing = 4					

a: Chi square $P < 0.01$. b: ANOVA $P < 0.01$, DM = diabetes mellitus, PDM = pregestational diabetes, GDM = gestational diabetes, HTN = hypertension, CHTN = chronic hypertension, GHTN = gestational hypertension, VD = vaginal delivery, VBAC = vaginal birth after cesarean, PCD = primary cesarean delivery, RCD = repeat cesarean delivery.

Table 2
Delivery descriptive characteristics of study population: singleton term deliveries in Minnesota 2011–2017

	Ethnicity/Birthplace n (%)				
Neonatal variables	**U.S. White**	**U.S. Black**	**Somali**	**Hispanic**	**Total**
Onset of Labor [a]					
Spontaneous	226823 (76.2)	15674 (78.5)	11067 (82.4)	37049 (82.1)	290613 (77.2)
Induced	70875 (23.8)	4293 (21.5)	2370 (17.6)	8063 (17.9)	85601 (22.7)
Total	297698	19967	13437	45112	376214
Frequency Missing = 1212					
Gestational Age (weeks) [a]					
37	22446 (7.5)	2067 (10.3)	625 (4.6)	3968 (8.8)	29106 (7.7)
38	44490 (14.9)	3670 (18.3)	1314 (9.7)	8156 (18.0)	57630 (15.3)
39	116605 (39.0)	7429 (37.1)	3568 (26.4)	17027 (37.6)	144629 (38.3)
40	81528 (27.3)	4828 (24.1)	4169 (30.9)	11629 (25.7)	102154 (27.1)
41	31790 (10.6)	1954 (9.8)	3044 (22.5)	4195 (9.3)	40983 (10.9)
42	1806 (0.6)	78 (0.4)	783 (5.8)	257 (0.6)	2924 (0.8)
Total	298665	20026	13503	45232	377426
Frequency Missing = 0					
Sex					
Male	152354 (51.1)	10078 (50.4)	6892 (51.2)	22811 (50.5)	192135 (51.0)
Female	145972 (48.9)	9902 (49.6)	6569 (48.8)	22351 (49.5)	184794 (49.0)
Total	298326	19980	13461	45162	376929
Frequency Missing = 497					
Mode of Delivery [a]					

	Ethnicity/Birthplace n (%)				
VD	206320 (69.1)	13963 (69.7)	9272 (68.7)	32814 (72.6)	262369 (69.5)
VBAC	13525 (4.5)	601 (3.0)	436 (3.2)	1351 (3.0)	15913 (4.2)
PCD	73775 (24.7)	4989 (24.9)	2873 (21.3)	9943 (22.0)	91580 (24.3)
RCD	4840 (1.6)	449 (2.2)	905 (6.7)	1091 (2.4)	7285 (1.9)
Unknown	205 (0.1)	24 (0.1)	17 (0.1)	33 (0.1)	279 (0.1)
Total	298665	20026	13503	45232	377426
NICU admission [a]	17324 (5.4)	2300 (10.3)	945 (6.6)	3191 (6.5)	
Maternal Age (years) [b]					
Mean (SD)	30 (5)	26 (6)	302 (5)	27 (6)	
Gestational Age (weeks) [b]					
Mean (SD)	39 (1)	39 (1)	40 (1)	39 (1)	
Newborn Birthweight (grams) [b]					
Mean (SD)	3507 (461)	3257 (467)	3434 (460)	3399 (4667)	

a: Chi square P < 0.01. b: ANOVA P < 0.01, DM = diabetes mellitus, PDM = pregestational diabetes, GDM = gestational diabetes, HTN = hypertension, CHTN = chronic hypertension, GHTN = gestational hypertension, VD = vaginal delivery, VBAC = vaginal birth after cesarean, PCD = primary cesarean delivery, RCD = repeat cesarean delivery, NICU = neonatal intensive care.

Cumulative fetal death rates per week were comparable between all ethnic groups up to 41 weeks, after which U.S. born Black and Hispanic fetal death rates were significantly higher compared with Somali and U.S. born White women (supplemental Fig. 1). Neonatal death rates followed a similar pattern. Somali neonatal death was comparable to all groups prior to 41 weeks, after which it remained lower compared with U.S. born Black and Hispanic women (supplemental Fig. 1). NICU admission was also similar between all groups except for U.S. born Black women who had significantly higher NICU admission rates compared with the rest of the population (Table 2).

Cumulative fetal death rates among ongoing pregnancies were lower than neonatal death rates at less than 39 weeks; these risks converged at 39 weeks for U.S. born White, U.S. born Black and Hispanic women. This effect was not observed until 40 weeks for Somali women. From the observed binomial proportions, the risk for fetal death in the Somali population remained lower than the risk of neonatal

death until 40 weeks (supplemental Fig. 2). After 40 weeks, this risk became higher than the neonatal mortality rate, but still below the rates observed for women of Hispanic or U.S. born Black ethnicity.

The adjusted odds ratio for fetal death and neonatal death among Somali newborns was higher compared with U.S. born White (aOR, 2.05 [95%CI: 1.49–2.83], aOR 1.84 [95%CI: 1.36–2.48]) and Hispanic women (aOR, 1.90 [95%CI: 1.30–2.79] and 1.47 [95%CI: 1.05–2.06] respectively) (Table 3). When analysis was limited to neonatal deaths among women after SOL, the risk for neonatal death was still greater among Somali women (aOR, 1.79 [95%CI: 1.26–2.54]) compared with U.S. born White women, but not increased compared with Hispanic women (aOR, 1.42 [95%CI: 0.96–2.11]) (supplemental table 2 also lists actual rates per week of gestation by ethnicity). There was no significant difference in risk for fetal death or neonatal death for all deliveries or after SOL compared with U.S. born Black women (aOR, 1.14 [95%CI: 0.75–1.74], 1.15 [95%CI: 0.80–1.66], and 1.05 [95%CI: 0.69–1.60] respectively). The aOR for fetal death among Somali women was not consistently different per week of gestation compared with the other ethnic groups. The aOR for neonatal death among Somali women was higher compared with the U.S. born White births up to 40 weeks, after which there was no difference. Compared with U.S. born Black and Hispanic births, there was no difference until after 41 weeks, when the rates among Somali births were significantly lower.

Table 3
Odds ratios for fetal death and neonatal deaths < 28 days in Minnesota from 2011–2017 for U.S. born White, U.S. born Black, Somali and Hispanic women.

	Adjusted OR Fetal death (95% CI)[a]			**Adjusted OR Neonatal death (95% CI)[a]**		
Week	**Somali : U.S. White**	**Somali : U.S. Black**	**Somali : Hispanic**	**Somali : U.S. White**	**Somali : U.S. Black**	**Somali : Hispanic**
37	2.17 (1.12–4.21)	1.08 (0.46–2.57)	1.72 (0.80–3.71)	1.90 (1.29–2.82)	1.95 (0.95–4.0)	2.09 (1.13–3.86)
38	0.32 (0.08–1.28)	0.33 (0.07–1.63)	0.22 (0.05–0.91)	1.42 (1.01–1.99)	1.08 (0.64–1.83)	1.82 (1.10–3.02)
39	1.87 (0.97–3.61)	0.66 (0.30–1.47)	2.67 (1.12–6.48)	2.08 (1.50–2.89)	1.60 (0.97–2.66)	1.57 (1.03–2.40)
40	1.85 (0.91–3.76)	0.72 (0.28–1.86)	1.79 (0.73–4.42)	2.40 (1.65–3.51)	0.94 (0.55–1.60)	1.63 (0.96–2.74)
41	2.19 (1.01–4.77)	1.71 (0.36–8.14)	3.00 (0.80–11.27)	1.37 (0.88–2.14)	1.01 (0.42–2.39)	0.73 (0.38–1.37)
42	0.66 (0.13–3.27)	0.21 (0.02–2.39)	0.32 (0.05–2.33)	0.54 (0.21–1.41)	0.10 (0.02–0.44)	0.08 (0.03–0.22)

a: Adjusted odds ratio (aOR) for maternal BMI, pregestational diabetes, pregestational hypertension, gestational diabetes, gestational hypertension and birthweight.

Discussion:

This large population-based study demonstrates that the overall adjusted odds for fetal death at term among Somali women is not different compared with the other ethnic groups analyzed. However, the adjusted odds ratios for neonatal death were higher compared with the U.S. born White population up to 40 weeks, after which there was no difference. Compared with U.S. born Black and Hispanic births, there was no difference until after 41 weeks, when the adjusted odds ratios among Somali infants were significantly lower. These relationships did not change after we limited our analysis to women who delivered after SOL.

The pattern for perinatal mortality followed the same pattern observed for neonatal mortality, with rates among Somali newborns higher than for the U.S. born White population, but not significantly different compared with the U.S. born Black and Hispanic population. After 40 weeks the adjusted odds ratios were not significantly different from those of U.S. born White but at 42 weeks, neonatal mortality was lower than rates observed between the two other main minority cohorts. After limiting to women who had SOL, we observed no change in this pattern.

Consistent with previous reports, mean gestational age at delivery after SOL among Somali women was one week later compared with all other ethnicities. The increased post term birth rate reported by the Ohio study shows that the frequency of late term and post term births decreased after comparing Somali women born in Somalia to those born outside of Somalia [1]. Although early work suggested that this could be due to acculturation and willingness to follow recommendations when health care provider recommended delivery, this has not been substantiated in subsequent studies [2].

Recent evidence supports elective induction of labor among otherwise healthy women at 39 weeks. This is associated with decreased cesarean delivery rates, and lower perinatal morbidity and mortality [11]. Our findings show that among Somali women, although a longer duration of gestation is associated with increased perinatal mortality compared with U.S. born White women it was not increased compared with U.S. born Black and Hispanic women up to 41 weeks. After 41 weeks, these relationships changed with increasing perinatal mortality for all ethnic groups although the increase was much greater for U.S. born Black and Hispanic women.

Prior publications regarding pregnancies in the Somali population have been reported from the states of Washington, Ohio and Minnesota [1,2,21]. Work from the states of Washington and Ohio discusses increased rates of late term and post-term births among Somali women, with contradictory data regarding neonatal outcomes and fetal deaths [1,2,22]. Adverse outcomes have been documented among Somali women having post term births [1,2]. The Washington State study reported increased risk for adverse obstetrical and neonatal outcomes compared with both Black and white newborns [2]. Similar neonatal outcome results were not observed from Ohio [1], where pregnancies were less often affected by hypertension yet more often complicated by diabetes, which is consistent with observations from Washington State and prior research done in Minnesota [2,21]. The adverse outcomes are increased compared with U.S. born white women but not with U.S. born Black women or African born Black women.

An important distinction between the two studies is that the earlier Washington study based gestational age on last menstrual period (LMP) while the Ohio study based gestational age on the best obstetrical estimate[1,2]. This difference may affect gestational age by as much as 2 to 3 weeks [23].

We did not specifically assess the impact of country of birth or time living in the U.S. among Somali women. Among African and Hispanic immigrant populations in the U.S., it has shown that immigrant women relative to U.S.-born women have a lower rate of preterm birth, lower birth weight and longer pregnancies [7,24], after controlling for the effect of the community, culture, and environment. This effect was attenuated over time [7]. The Ohio cohort study also noted that the observed lower rates of prematurity as well as the higher rate of post term birth decreased over time when comparing Somali women born in the U.S. with those born in Somalia [1]. Although we did not specifically address preterm birth rates in our study, in Fig. 1 it is evident that late preterm birth rates are lower among Somali women.

Our data does not include all outcomes reported in the previous studies; it does focus the discussion regarding perinatal mortality on neonatal deaths, given the lack of differences in fetal death rates between the ethnicities analyzed. Although most studies have compared Somali neonatal deaths to the U.S. born White population, the evidence is not clear whether the higher neonatal death rates observed, which are similar to that of U.S. born Black and Hispanic women, are dependent on minority or immigrant status, or ethnicity [25–27]. The main difference attributable to Somali ethnicity is that neonatal death rates did not increase despite having a greater mean gestational age at delivery. After 41 weeks, it was comparable to that of U.S. born White women and lower than that of the other ethnicities.

Despite having the largest Somali diaspora in the country [1] there is limited information on late term and post term birth rates within this group in Minnesota. Although trends showing the effect of acculturation have reported greater maternal weight gain and preterm births rates, this is limited to early or first generation Somali women [21]. Our current analysis has allowed us to evaluate a longer-term effect of acculturation and environment now that there is a generation of Somali women who have been born in the U.S. and are having children of their own.

The data show that despite acculturation, mean gestational age at delivery is delayed by one week within the Somali population compared with the rest of the population. Previous work in Minnesota compared Somali women delivering between 1993 and 1999 with those who delivered between 2000 and 2006. They measured factors hypothesized to reflect acculturation and their relationship to the higher preterm birth rates expected over time among immigrant Somali women. The factors evaluated and thought to reflect acculturation and affect birth outcomes among Somali women such as age at immigration, years lived in the U.S. and English language proficiency did not account for the observed increase in the preterm birth rate. However increased incidence of maternal obesity and gestational diabetes did, suggesting that diet and obesity may play a larger role in the observed increasing rate of preterm birth in this population, while prenatal care utilization prevented preterm birth [21]. The association of pregnancy outcome with gestational diabetes (GDM) is consistent with a large meta-analysis of over 120,000 women that

evaluated the risk for GDM among migrant women comparted with the non-migrant population. Migrant women had higher rates of GDM than non-immigrant women [28].

Determining whether initiation of birth was spontaneous or by induction of labor, cesarean without labor or membrane rupture is critical in surveillance and etiological research on preterm birth [19]. The same holds true for post term birth and risks for adverse perinatal outcome[9]. Whether factors influencing preterm birth rates can affect post term birth rates remains to be determined. If factors such as diet and the development of GDM can affect the overall duration of pregnancy and timing of SOL, Somali women would provide an excellent reference to evaluate how factors such as dietary changes over time could change perinatal outcomes by shortening duration of pregnancy. It remains to be seen what factors are influencing neonatal mortality in the minority populations included, but it is likely that cultural and socioeconomic factors play a large role especially regarding access to care.

In conclusion, Somali women on average delivery later than the rest of the population. Despite this difference, fetal death rates are not different compared with the rest of the population. Neonatal mortality however is increased compared with the U.S. born White population, but similar to that of other minorities in Minnesota. After 40 weeks, neonatal mortality decreases compared with other minorities and is comparable to that of the U.S. born White population. This information is consistent with previous work demonstrating that minority and immigrant populations have been and continue to be at risk for adverse neonatal outcomes. These findings provide a framework within which to evaluate biological and cultural factors that can affect duration of pregnancy and neonatal outcomes.

List Of Abbreviations:

aOR: adjusted odds ratio

U.S.: United States of America

CI: confidence interval

SOL: spontaneous onset of labor

IOL: induction of labor

IRB: Institutional Review Board

CDC: Centers for Disease Control and Prevention

ANOVA: analysis of variance

BMI: body mass index

STROBE: Strengthening the Reporting of Observational Studies

LMP: last menstrual period

GDM: gestational diabetes mellitus

Declarations:

Ethics approval and consent to participate:

Approval to perform this study and waiver for informed consent was obtained from the Institutional Review Board of the University of Minnesota in Minneapolis, MN (IRB submission 00004909) as well as by a Data Use Agreement established with the Minnesota Department of Health (MDH-1901). The data provided was anonymized by the Minnesota Department of Health, and was a condition for the data use agreement. No personal identifying information is available in the summary data provided in this manuscript. We confirm that all methods were performed in accordance with the relevant guidelines and regulations (Declaration of Helsinki).

Consent for publication:

not applicable.

Availability of data and materials:

The data that support the findings of this study are available from the Minnesota Department of Health through submission of a Data Use Agreement, but restrictions apply to the availability of these data, which were used under license for the current study, and so are not publicly available. Data are however available from the authors upon reasonable request and with permission of the Minnesota Department of Health. The Minnesota Department of Health will not release individual level data to protect individuals who could be identified from areas with small numbers of live births, fetal or neonatal deaths. The summary data from which the calculations are derived are available in Table 2 of the supplemental data.

Competing interests:

The authors declare that they have no competing interests.

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Authors' contributions:

S.C. and I.B. contributed to study conception and design.

S.C. performed statistical analysis and prepared all figures and graphs.

S.C., R.N., I.B., and J.A. contributed to writing and reviewing the manuscript.

S.C., R.N., I.B., and J.A. have all read and approved the final version of the manuscript.

S.C., R.N., I.B., and J.A. have all agreed both to be personally accountable for the author's own contributions and to ensure that questions related to the accuracy or integrity of any part of the work, even ones in which that author was not personally involved, are appropriately investigated, resolved, and the resolution documented in the literature.

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Figures

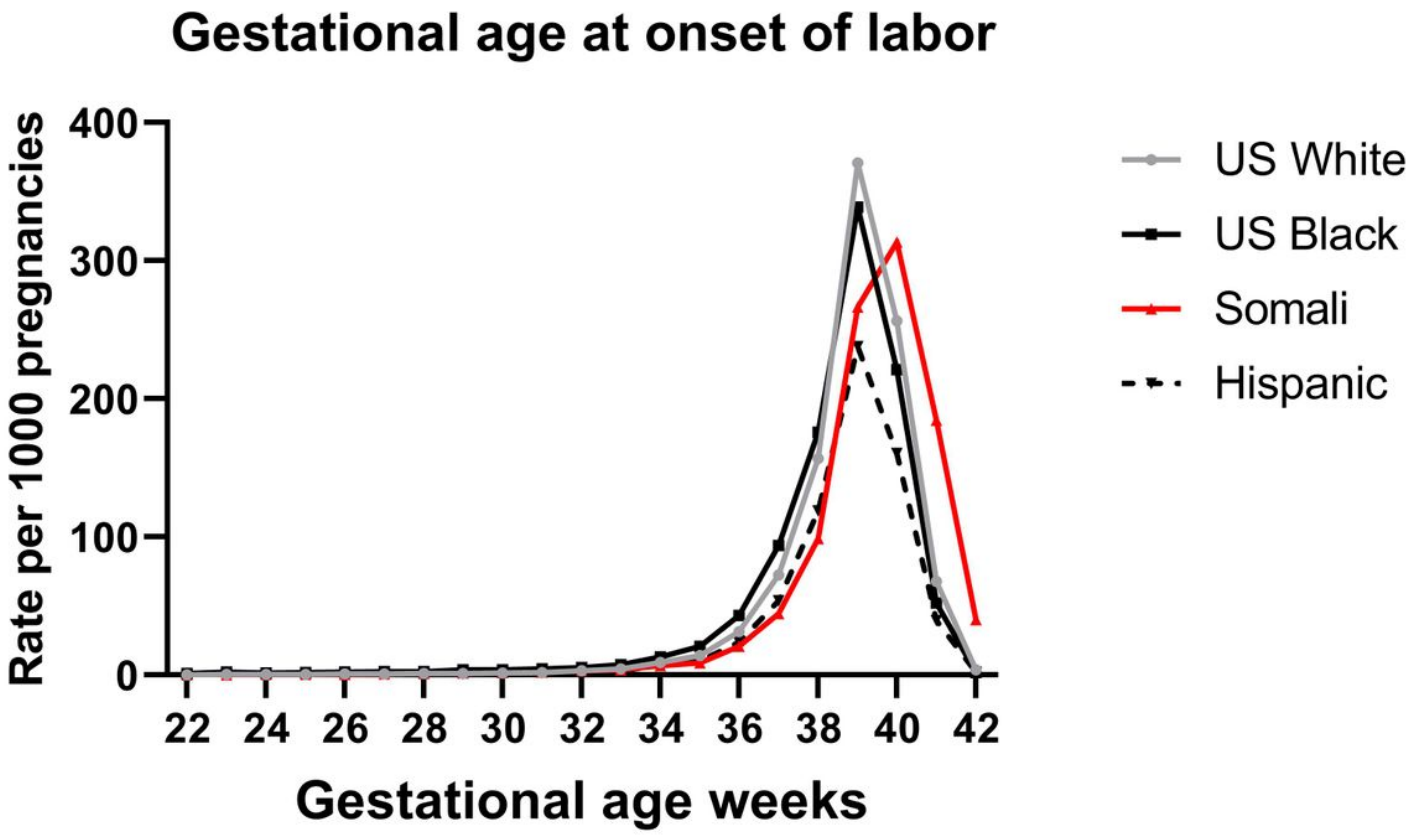

Figure 1

Birth rates distribution by gestational age after spontaneous onset of labor in Minnesota from 2011-2017 for U.S .born White, U.S. born Black, Somali and Hispanic women.

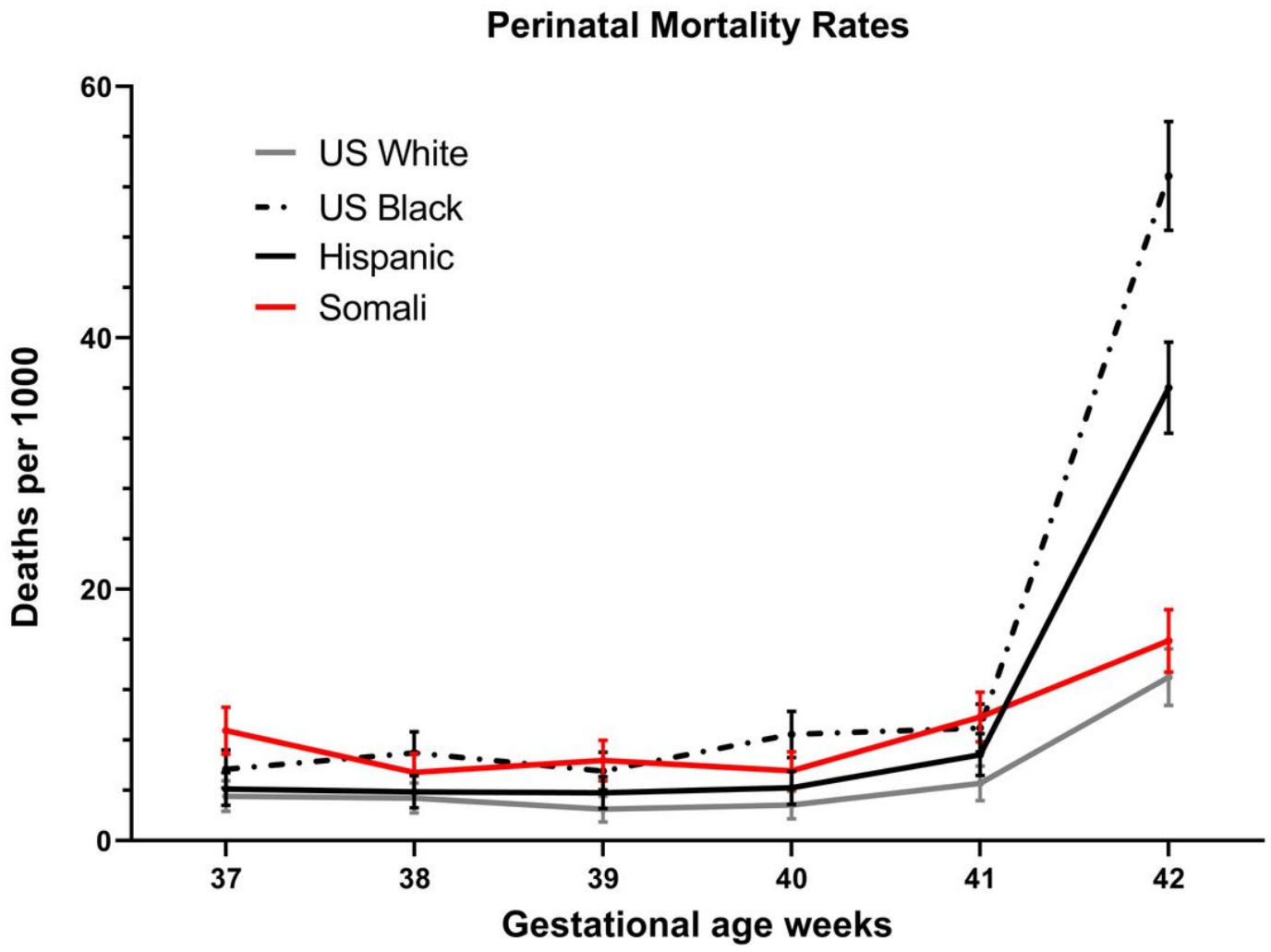

Figure 2

Perinatal mortality in Minnesota from 2011-2017: binomial rates with 95% confidence intervals for U.S .born White, U.S. born Black, Somali and Hispanic women.

Supplementary Files

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- SupplementalFiguresandTables.docx