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Pregnancy, Birth, and Infant Outcomes Among Women Who Are Deaf or Hard of Hearing

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Abstract

Introduction: Being deaf or hard of hearing (DHH) can be marginalizing and associated with inequitable health outcomes. Until recently, there were no U.S. population-based studies of pregnancy outcomes among DHH women. In light of inconsistent findings in the limited available literature, this study sought to conduct a more rigorous study using population-based, longitudinal linked data to compare pregnancy complications, birth characteristics, and neonatal outcomes between DHH and non-DHH women.

Methods: Researchers conducted a retrospective cohort study in 2019 using the Massachusetts Pregnancy to Early Life Longitudinal data system. This system links all Massachusetts birth certificates, fetal death reports, and delivery and non-delivery related hospital discharge records for all infants and their mothers. The study included women with singleton deliveries who gave birth in Massachusetts between January 1998 to December 2013.

Results: The DHH women had an increased risk of chronic medical conditions and pregnancy complications including: pre-existing diabetes, gestational diabetes, pre-eclampsia and eclampsia, and placental abruption. Deliveries to DHH women were significantly associated with adverse birth outcomes, including: preterm birth, low birth weight or very low weight, and low 1-minute Apgar score or low 5-minute Apgar score. No significant differences were found in size for gestational age, fetal distress, or stillbirth among DHH women.

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Conclusions: Findings from this 2019 study indicate that DHH women are at a heightened risk for chronic conditions, pregnancy-related complications, and adverse birth outcomes, and underscore the need for systematic investigation of the pregnancy and neonatal related risks, complications, costs, mechanisms, and outcomes of DHH women.

INTRODUCTION

Approximately 4.7% of U.S. women aged 18–39 years report hearing loss (National Health Interview Survey, 2014). Being deaf or hard of hearing (DHH) can be marginalizing, and associated with lower SES, inequitable health outcomes, and elevated risk of depression and anxiety disorders.[1–9] There may be a biological basis for some adverse health outcomes experienced by DHH individuals[10–13]; however, inadequate health communication between providers and DHH individuals impedes access to health care and health information and likely contributes to poorer outcomes.[14–17]

Until recently, there were no U.S. population-based studies of pregnancy outcomes among DHH women.[18] A 2016 study by Mitra et al.[18] used the 2008–2011 Nationwide Inpatient Sample of the Healthcare Cost and Utilization Project to compare birth outcomes in U.S. women with and without hearing loss. In adjusted regression analyses, they found women with hearing loss were significantly more likely than other women to have preterm birth and low birth weight. Schiff and colleagues[19] conducted a retrospective cohort study using linked birth, fetal death, and hospital discharge data from the state of Washington to examine the association between deafness among pregnant women and selected adverse pregnancy outcomes. Interestingly, in this study most adverse pregnancy and neonatal outcomes, including small for gestational age and preterm birth, were similar for deaf women and women in the comparison group in the state of Washington.

In light of these inconsistent findings, this study sought to conduct a more rigorous study using population-based, longitudinal linked data to compare pregnancy complications, birth characteristics, and neonatal outcomes between DHH and non-DHH women.

METHODS

The study data were derived from the Massachusetts Pregnancy to Early Life Longitudinal (PELL) data system, a longitudinal, population-based, reproductive health data set. PELL data link all Massachusetts birth certificates, fetal death reports, and delivery and non–delivery (inpatient visits, observational stays, and emergency department visits) related hospital discharge records for all infants and their mothers. The PELL data set includes >100 clinical and nonclinical data elements for each delivery, including primary and secondary diagnoses and procedures. Detailed information on the design of the PELL data set is available elsewhere.[20,21]

Study Sample

The study population includes women with singleton deliveries who gave birth in Massachusetts between January 1998 and December 2013. DHH status of the woman was identified using primary and secondary diagnoses in any hospital admission, emergency department visit, or observational stay up to the time of delivery. Women were categorized as DHH if they had any history of hearing loss diagnoses based on the ICD-9 CM codes (389.0, 389.1, 389.2, 389.7, 389.8, and 389.9) present on the hospital discharge record.[18,22] Among 1,189,860 deliveries between 1998 and 2013 in Massachusetts, 2,569 (0.21%) deliveries among DHH women were identified. This study included the cohort of women (*n*=1,385) who were identified as having DHH status before or at the time of delivery. The remaining cohort of singleton deliveries to women who were not categorized as DHH were used as a comparison group. The final study sample consisted of 1,188,676 deliveries, including 1,385 deliveries to DHH women and 1,187,291 deliveries to non-DHH women.

To identify differences in the study sample between DHH women and non-DHH women, researchers compared maternal demographic (age, race/ethnicity, birth place, language used at home) and socioeconomic (education, marital status, father named on birth certificate, health insurance) characteristics, smoking during pregnancy, parity, and adequacy of prenatal care. Adequacy of prenatal care was measured by the Kotelchuck index[23,24] (inadequate, intermediate, adequate, or adequate plus). Chi-square tests were used to compare categorical variables and *t*-tests were used for continuous variables.

Measures

This study examined chronic pre-existing medical conditions, pregnancy-related complications, and complications during labor and delivery among DHH and non-DHH women. Chronic health conditions included pre-gestational diabetes (ICD-9 codes 250, 362.0, 648.01, and 648.02) and chronic hypertension (ICD-9 codes 401–405, 642, 642.0–642.2, 642.7, and 642.9). Pregnancy-related complications included the following: gestational diabetes (ICD-9 code 648.8), pre-eclampsia and eclampsia (ICD-9 codes 642.4, 642.5, and 642.9), placenta previa (ICD-9 code 641.0, 641.1, and 762.0), and placental abruption (ICD-9 codes 641.2, 762.1). Labor complications included in this study were chorioamnionitis (ICD-9 codes 658.4, 762.7), breech (ICD-9 codes 652.2, 669.6, and 763.0), use of forceps or vacuum during vaginal delivery (ICD-9 procedure codes 72.0–72.4, 72.6–72.7), labor induction (ICD-9 diagnosis codes 659.0 and 659.1 and procedure codes 73.01, 73.1, 73.4, and 96.49), and cesarean delivery (ICD-9 diagnosis codes 669.7 and 763.4 and procedure codes 74, 74.1, 74.2, 74.4, and 74.9). To enhance accurate identification of these complications, the authors linked birth certificate data and the ICD-9-CM discharge diagnosis codes to identify these complications.

Researchers assessed length of hospital stay for vaginal and cesarean delivery. Finally, this study compared birth outcomes including preterm birth (delivery <37 completed weeks of gestation), low birth weight (birth weight <2,500 g), very low birth weight (birth weight <1,500 g), fetal distress (ICD-9 codes 656.3, 768.2–768.4), 1-minute Apgar score <7, 5-minute Apgar score <7, size for gestational age (small [ICD-9 code 656.5], appropriate, large [ICD-9 code 656.6]), and stillbirth (ICD-9 codes 656.4, 656.40, 656.41, 656.43, 768.0, 768.1, V27.1, V27.3, and V27.4.) by DHH status. Similar to pregnancy complications, the researchers linked birth certificate data and the ICD-9-CM codes to ascertain these birth outcomes.

Statistical Analysis

The authors compared the risk of adverse pregnancy and birth outcomes between deliveries to DHH and non-DHH women using Poisson (for binary variables) and multinomial logistic (for categorical variables) regressions. Recognizing that the sample could include more than one delivery to the same mother during the study period, analyses adjusted for individual-level clustering by using the robust clustered sandwich estimator method[25] and used a two-step approach to avoid over-adjustment bias.[19,26] In the first step, multivariable models adjusted only for maternal age, parity, and birth year (Model 1). In the second step, multivariable models adjusted for additional covariates (Model 2), including race/ethnicity, maternal education, language used at home, marital status, health insurance status, smoking, and adequacy of prenatal care based on the Kotelchuck index,[23,24] and assessed how these additional covariates influenced the results from Model 1. If the additional inclusion had led to too large a change in the estimates of Model 1, one would have suspected over-adjustment bias and reconsidered the final Model 2 specifications. In this study, however, there was not sufficient change from Model 1 estimates to raise concerns about over-adjustment. Because a number of covariates in Model 2 had missing values, the researchers conducted chained multiple imputation for analyses, consistent with best practices.[27,28] Further, the researchers tested for the differential effect of confounding among variables that are known risk factors (e.g., smoking, age, race/ethnicity, and marital status) for pregnancy complications and adverse birth outcomes by including interaction terms between these variables and DHH status in the regression models. All analyses were performed in 2019 using Stata, version 15 MP.[29]

The study was deemed exempt by Brandeis University IRB in 2017.

RESULTS

Compared with non-DHH women, DHH women were more likely to be younger, be non-Hispanic black or Hispanic, report fewer years of education, be U.S.-born, use a language other than English to discuss health issues, have public health insurance, and receive “adequate plus” prenatal care based on the Kotelchuck index.[23,24] They were less likely to be married or to have identified a father on the child’s birth certificate. DHH women were more likely to have smoked during pregnancy (Table 1).

The DHH women had an increased risk of chronic medical conditions and pregnancy complications including: pre-existing diabetes (2.6% vs 1.1%, RR=2.40, 95% CI=1.61, 3.59, $p<0.001$), chronic hypertension (2.6% vs 1.9%, RR=1.39, 95% CI=1.00, 1.93, $p<0.05$), gestational diabetes (8.7% vs 5.4%, RR=1.59, 95% CI=1.31, 1.92, $p<0.001$), pre-eclampsia and eclampsia (6.3% vs 4.8%, RR=1.32, 95% CI=1.07, 1.63, $p<0.01$), placental abruption (1.6% vs 0.8%, RR=1.98, 95% CI=1.31, 2.99, $p<0.01$), cesarean delivery (32.1% vs 28.7%, RR=1.12, 95% CI=1.03, 1.22, $p<0.05$), and staying >4 days in the hospital after vaginal delivery (7.5% vs 5.2%, RR=1.12, 95% CI=1.03, 1.22, $p<0.05$) (Table 2).

These results were somewhat attenuated after controlling for covariates in Model 1 and Model 2 but DHH status continued be associated with most pregnancy complications (Table 2). The adjusted RR of cesarean delivery and staying >4 days in the hospital after vaginal delivery did not differ significantly in the adjusted models. There were no significant differences in the risk of chronic hypertension, placenta previa, chorioamninitis, pre-eclampsia and eclampsia, breech, use of forceps, labor induction, and staying >4 days in the hospital after cesarean delivery between DHH and non-DHH women.

Deliveries to DHH women were significantly associated with adverse birth outcomes, including: preterm birth (9.2% vs 7.1%, RR=1.34, 95% CI=1.12, 1.64, $p<0.01$), low birth weight (7.2% vs 5.6%, RR=1.30, 95% CI=1.05, 1.59, $p<0.05$) or very low weight (2.0% vs 1.1%, RR=1.82, 95% CI=1.22, 2.73, $p<0.01$), small for gestational age (10.3% vs 8.6%, RR=1.21, 95% CI=1.01, 1.48, $p<0.05$), and low 1-minute Apgar score (9.8% vs 7.5%, RR=1.30, 95% CI=1.06, 1.59, $p<0.01$) or low 5-minute Apgar score (2.2% vs 1.2%, RR=1.93, 95% CI=1.31, 2.83, $p<0.01$) (Table 3). The adjusted RR of small for gestational age did not differ significantly in the adjusted models. There was no significant difference found in fetal distress or stillbirth. Results from interaction of DHH status with smoking during pregnancy, race/ethnicity, age, and marital status did not show any moderating effects of DHH status on the risk of pregnancy complications and adverse birth outcomes.

DISCUSSION

The present study documents disparities in pregnancy complications and birth outcomes among DHH women in comparison to their non-DHH peers using population-based, longitudinal, linked data. After adjusting for demographics, DHH women were at an increased risk of chronic conditions, pregnancy complications, and specific adverse birth outcomes including preterm birth and very low birth weight.

The findings of this study are consistent with earlier findings by Mitra et al.[18] and contradict the findings of Schiff and colleagues.[19] The discrepancies in the findings between this study with the Schiff et al. study may be explained in several ways. First, though both studies used similar ICD-9 codes to identify DHH status, this study used linked longitudinal data from 1998 to 2013 to identify DHH status through primary and secondary diagnoses in any hospital admission, emergency department visit, or observational stay up to the time of delivery. Contrarily, using cross-sectional data from 1987 to 2012, Schiff and colleagues identified DHH status among delivery-related hospitalization records. Establishing DHH status using delivery-related hospitalization records likely under-ascertains the number of DHH women and conservatively biases the results. It is possible that some DHH women would not be assigned the ICD-9 code for DHH as the main reason for their childbirth hospitalization. In addition, the discrepancies in the study findings might reflect differences in state-level policies and healthcare access between the states of Massachusetts and Washington. For example, the PELL data set included years 1998–2013, prior to the implementation of the main features of the Affordable Care Act. Massachusetts, starting in 2006, successfully covered approximately two thirds of the state's then-uninsured residents through a series of federal and state-funded mandates (MassHealth and the Connector).[30] Washington State did not largely implement Medicaid expansion until the passage of the Affordable Care Act. Additionally, Washington State's uninsured rate was 14%, in 2013 in contrast to Massachusetts' 3.7%.[31,33] It is unclear if there are disability-related policies or training differences that exist between these two states.

There are several possible explanations for these findings. First, individuals who are DHH frequently struggle with healthcare communication and this may be a potential driver for some of the disparities that were identified.[15,16] Nearly 42% of DHH women in this study reported using a language other than English despite being more likely to be U.S.-born. This is possibly reflective of a large proportion of Deaf signers among the DHH women in the PELL data set, although this study is unable to ascertain this. Existing studies suggest that Deaf signers are much more likely to be marginalized in healthcare settings.[15,17] Unfortunately, effective communication is infrequently achieved, with one study reporting only 17% of Deaf signers being provided with a sign language interpreter.[34] Even among non-signers, hearing loss represents a significant source of communication challenges in the healthcare setting, affecting healthcare delivery to these individuals.[15,35] DHH individuals have double the risk of nonadherence, along with reduced patient–provider communication satisfaction.[16,36] Poor communication between providers and patients results in a variety of adverse outcomes, including reduced patient treatment adherence, inappropriate use of health services, and less awareness of healthy behaviors.[37–42]

In general, DHH individuals are at increased risk of a variety of health conditions[2,4] but it is less clear if this is the case with reproductive-age DHH women. In this study, DHH women were more likely to have pre-existing diabetes but not chronic hypertension. Several articles have confirmed this higher risk of diabetes among individuals with hearing loss.[4,11] It is believed that the mechanism is likely due to microvascular injury to the hearing apparatus. Other potential bio-behavioral factors explaining the pregnancy and birth disparities may include the role of genetics and coexisting conditions. There are more than 400 identified hearing loss genes, with little knowledge about their phenotypes and clinical correlates.[39] A significant portion of the DHH women in this study likely have congenital hearing loss. During the past few decades, there has been a major shift in the etiology of congenital hearing loss, moving away from congenital infection etiologies to genetic origins and prematurity sequelae.[7,40] Furthermore, smoking during pregnancy was higher among DHH women. This is concerning because tobacco use during pregnancy is a well-established risk for preterm birth and a variety of pregnancy complications.[41,42] However, interaction analyses did not show any significance with any of the main birth outcomes reported herein.

Lastly, DHH individuals, as well as people with other types of disabilities, are at higher risk for increased stress, depression, anxiety, and interpersonal violence, factors that may impact pregnancy outcomes.[5,43–46] For example, a systematic review demonstrated that interpersonal violence can significantly elevate the risk of low birth weight and preterm birth.[47] Furthermore, DHH individuals struggle with social marginalization with few, if any, accessible resources to address victimization during the pregnancy period.

Limitations

This study has important limitations relating to its data source. First, there was no process of clinical and audiometric corroboration of the data. As coding rules specify that only diagnoses actively treated during hospitalization should be listed, it is possible that some women who are DHH were not identified because their ICD-9-CM codes were not entered and deliveries to DHH women were likely under-ascertained. However, previous studies have also used ICD-9-CM codes to identify DHH status.[48,49] Secondly, the data source lacked information on how communication occurred between the healthcare provider and the DHH woman. Third, certain pregnancy and birth outcomes are uncommon and the data source lacked an adequate sample size of DHH women to analyze these outcomes (e.g., placenta previa and stillbirths). Finally, DHH women are a heterogeneous group, and there are likely differences in pregnancy complications and outcomes among DHH women. Future research should consider the extent to which different outcomes occur to different groups of DHH women, including those with congenital versus later onset of hearing loss.

CONCLUSIONS

The findings from this study indicate that DHH women are at a heightened risk for chronic conditions, pregnancy-related complications, and adverse birth outcomes, and underscore the need for a systematic investigation of the pregnancy- and neonatal-related risks, complications, costs, mechanisms, and outcomes of DHH women. Additional research is also needed to understand the experiences of DHH women during pregnancy, childbirth, and postpartum, and to develop effective and evidence-based clinical and policy interventions to improve these outcomes.

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MM takes responsibility for the integrity of the data and the accuracy of the data analysis. Study concept and design was done by MM and MMMcK. Statistical analysis was conducted by IA and JZ. GR advised on statistical analysis design. Drafting and revision of the manuscript was conducted by MM, MMMcK, KMcK, IA, JZ, G, LI, and AV.

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Table 1.

Maternal Characteristics Among Singleton Deliveries to DHH Women and Non-DHH Women in Massachusetts, 1998–2013, N=13,258

Characteristics	DHH (N=l,385)	Non-DHH (N=l,187,291)	*p*-value[a]
	n (%)	n (%)	
Maternal age, years			**<0.001**
<20	82 (5.9)	72,048 (6.1)	
20–24	289 (20.9)	184,284 (15.5)	
25–34	356 (25.7)	291,252 (24.5)	
35–39	370 (26.7)	380,620 (32.1)	
≥40	288 (20.8)	259,067 (21.8)	
Maternal race/ethnicity			**<0.001**
Non-Hispanic white	896 (64.7)	818,061 (68.9)	
Non-Hispanic black	135 (9.7)	97,514 (8.2)	
Hispanic	264 (19.1)	163,235 (13.7)	
Other	89 (6.4)	105,470 (8.9)	
Missing	<11[b] (0.1)	3,011 (0.3)	
Maternal education			**<0.001**
Less than high school	210 (15.2)	141,498 (11.9)	
High school or GED	581 (41.9)	411,023 (34.6)	
Some college	188 (13.6)	136,683 (11.5)	
College and higher	394 (28.4)	492,649 (41.5)	
Missing	12 (0.9)	5,438 (0.5)	
Marital status			**<0.001**
Married	730 (52.7)	817,210 (68.8)	
Not married	651 (47.0)	366,981 (30.9)	
Missing	<11[b] (0.3)	3,100 (0.3)	
Mother's place of birth			**<0.001**
U.S. born	1,125 (81.2)	880,695 (74.2)	
Foreign born	259 (18.7)	305,999 (25.8)	
Missing	<11[b] (0.1)	597 (0.0)	
Language used at home			**<0.001**
English	798 (57.6)	886,595 (74.7)	
Other	581 (41.9)	294,589 (24.8)	
Missing	<11[b] (0.4)	6,107 (0.5)	
Father named at delivery			**<0.001**
No	172 (12.4)	97,146 (8.2)	
Yes	1,212 (87.5)	1,090,051 (91.8)	
Missing	<11[b] (0.1)	94 (0.0)	
Health insurance			**<0.001**

Characteristics	DHH (N=l,385)	Non-DHH (N=l,187,291)	*p*-value[a]
	n (%)	n (%)	
Private	636 (45.9)	785,123 (66.1)	
Public	746 (53.9)	397,572 (33.5)	
Missing	<11[b] (0.2)	4,596 (0.4)	
Smoking during pregnancy			**<0.001**
No	1,222 (88.2)	1,088,983 (91.7)	
Yes	163 (11.8)	97,397 (8.2)	
Missing	0 (0.0)	911 (0.1)	
Parity			0.195
First pregnancy	655 (47.3)	538,058 (45.3)	
Second pregnancy	431 (31.1)	402,219 (33.9)	
Third or higher	293 (21.2)	241,995 (20.4)	
Missing	<11[b] (0.4)	5,019 (0.4)	
Kotelchuck Index[c]			**<0.001**
Inadequate	17 (1.2)	13,277 (1.1)	
Intermediate	110 (7.9)	93,821 (7.9)	
Adequate	546 (39.4)	544,660 (45.9)	
Adequate plus	678 (49.0)	511,429 (43.1)	
Missing	34 (2.5)	24,104 (2.0)	
Maternal age, years, mean (SE)	28.9 (0.17)	29.6 (0.01)	**0.001**

Notes: Data n (%) unless otherwise specified. Boldface indicates statistical significance ($p<0.05$).

[a] *P*-values for differences, Chi square-test or *t*-test.

[b] To maintain confidentiality, cells with <11 cases cannot be reported.

[c] Adequacy of prenatal care characterized as adequate plus, adequate, intermediate or less than adequate using Kotelchuck index.[23,24]

Source: Massachusetts Pregnancy to Early Life Longitudinal Data System (PELL), 1998–2013.

DHH, Deaf or Hard of Hearing.

Table 2.

Medical Complications During Pregnancy and Birth Outcomes Among Singleton Deliveries to DHH Women and Non-DHH Women in Massachusetts, 1998–2013, N=1,188,676

Complications/Outcomes[a]	DHH (N=1,385)	Non-DHH (N=1,187,291)	Unadjusted	Model 1[b]	Model 2[c]
	%	%	RR (95% CI)	RR (95% CI)	RR (95% CI)
Chronic health conditions					
Pre-existing diabetes					
No	97.4	98.9	ref	ref	ref
Yes	2.6	1.1	**2.40*** (1.61, 3.59)**	**2.37*** (1.58, 3.54)**	**2.15*** (1.44, 3.21)**
Chronic hypertension					
No	97.4	98.1	ref	ref	ref
Yes	2.6	1.9	**1.39* (1.00, 1.93)**	1.30 (0.94, 1.80)	1.19 (0.85, 1.64)
Pregnancy related complications					
Gestational diabetes					
No	91.3	94.6	ref	ref	ref
Yes	8.7	5.4	**1.59*** (1.31, 1.92)**	**1.50*** (1.24, 1.81)**	**1.40*** (1.17, 1.69)**
Pre-eclampsia and eclampsia					
No	93.7	95.2	ref	ref	ref
Yes	6.3	4.8	**1.32** (1.07, 1.63)**	**1.25* (1.02, 1.54)**	1.21 (0.98, 1.48)
Placenta previa					
No	99.4	99.5	ref	ref	ref
Yes	0.6	0.5	1.25 (0.63, 2.49)	1.23 (0.62, 2.46)	1.17 (0.59, 2.33)
Placental abruption					
No	98.4	99.2	ref	ref	ref
Yes	1.6	0.8	**1.98** (1.31, 2.99)**	**1.95** (1.29, 2.96)**	**1.84** (1.22, 2.79)**
Labor complications					
Chorioanmionitis					
No	98.1	97.6	ref	ref	ref
Yes	1.9	2.4	0.80 (0.54, 1.16)	0.81 (0.56, 1.19)	0.83 (0.57, 1.22)
Breech					
No	96.0	96.1	ref	ref	ref
Yes	4.0	3.9	1.04 (0.80, 1.34)	1.14 (0.89, 1.48)	1.13 (0.88, 1.47)
Use of forceps or vacuum during delivery[d]					
No	93.6	93.6	ref	ref	ref
Yes	6.4	6.4	1.00 (0.78, 1.29)	1.11 (0.87, 1.43)	1.15 (0.90, 1.48)
Labor induction					
No	74.6	75.3	ref	ref	ref
Yes	25.4	24.7	1.03 (0.94, 1.13)	1.01 (0.92, 1.11)	1.01 (0.92, 1.11)

Complications/Outcomes[a]	DHH (N=1,385)	Non-DHH (N=1,187,291)	Unadjusted	Model 1[b]	Model 2[c]
	%	%	RR (95% CI)	RR (95% CI)	RR (95% CI)
Method of delivery					
Vaginal	67.9	71.3	ref	ref	ref
Cesarean	32.1	28.7	**1.12 * (1.03, 1.22)**	1.08 (0.99, 1.18)	1.05 (0.96, 1.14)
Length of stay during cesarean delivery, days					
<2	0.5	0.5	ref	ref	ref
2–3	18.8	19.9	1.22 (0.30, 4.96)	1.11 (0.27, 4.52)	1.17 (0.29, 4.80)
≥4	80.7	79.6	1.31 (0.33, 5.25)	1.18 (0.29, 4.75)	1.34 (0.33, 5.41)
Length of stay during vaginal delivery, days					
<2	4.9	5.8	ref	ref	ref
2–3	87.5	89.0	1.15 (0.85, 1.55)	1.09(0.81, 1.48)	1.13(0.83, 1.54)
≥4	7.5	5.2	**1.58 * (1.08, 2.32)**	1.42 (0.95, 2.12)	1.37 (0.92, 2.04)

Notes: Data are n (%) of deliveries, unless otherwise specified. Boldface indicates statistical significance (****p*<0.001; ***p*<0.01; **p*< 0.05).

[a]Complications/Outcomes are based on the chapter 11 of the ICD-9-CM codes.[46]

[b]Adjusted for maternal age, parity, and birth year.

[c]Adjusted for maternal age, race/ethnicity, language, maternal education, marital status, health insurance, parity, smoking, and birth year.

[d]Only for vaginal deliveries.

Source: Pregnancy to Early Life Longitudinal (PELL) Data, 1998–2013.

DHH, Deaf or Hard of Hearing.

Table 3.

Birth Outcomes Among Singleton Deliveries to DHH Women and Women in General Obstetric Population in Massachusetts, 1998–2013, N=1,188,676

Outcomes	DHH (N=1,385)	Non-DHH (N=1,187,291)	Unadjusted	Model 1[a]	Model 2[b]
	%	%	RR (95% CI)	RR (95% CI)	RR (95% CI)
Preterm birth (<37 weeks)					
No	90.8	92.9	ref	ref	ref
Yes	9.2	7.1	**1.30** ** **(1.10, 1.55)**	**1.31** ** **(1.09, 1.57)**	1.19 (0.99, 1.44)
Low birth weight (<2,500g)					
No	92.8	94.4	ref	ref	ref
Yes	7.2	5.6	**1.27** * **(1.05, 1.55)**	**1.25** * **(1.02, 1.53)**	1.12 (0.91, 1.38)
Very low birth weight (<1,500g)					
No	98.0	98.9	ref	ref	ref
Yes	2.0	1.1	**1.77** ** **(1.23, 2.55)**	**1.79** ** **(1.23, 2.60)**	**1.71** ** **(1.17, 2.51)**
Size for gestational age					
Small	10.3	8.6	**1.21** * **(1.01, 1.48)**	1.15 (0.94, 1.40)	1.06 (0.86, 1.29)
Average	80.7	81.3	ref	ref	ref
Large	9.0	10.1	0.90 (0.73, 1.11)	0.97 (0.78, 1.19)	0.99 (0.80, 1.22)
Fetal distress					
No	97.1	96.8	ref	ref	ref
Yes	2.9	3.2	0.90 (0.66, 1.22)	1.03 (0.75, 1.41)	1.00 (0.72, 1.37)
Apgar score at 1 minute less than 7					
No	90.2	92.5	ref	ref	ref
Yes	9.8	7.5	**1.30** ** **(1.07, 1.57)**	**1.32** * **(1.07, 1.64)**	**1.24** * **(1.00, 1.54)**
Apgar score at 5 minutes less than 7					
No	97.8	98.8	ref	ref	ref
Yes	2.2	1.2	**1.91** *** **(1.35, 2.71)**	**1.87** *** **(1.31, 2.67)**	**1.72** ** **(1.20, 2.46)**
Stillbirth					
No	99.4	99.6	ref	ref	ref
Yes	0.6	0.4	1.35 (0.67, 2.69)	1.18 (0.63, 2.20)	1.30 (0.70, 2.43)

Notes: Data are n (%) of deliveries, unless otherwise specified. Boldface indicates statistical significance (****p*<0.001; ***p*<0.01; **p*< 0.05).

[a]Adjusted for maternal age, parity, and birth year.

[b]Adjusted for maternal age, race/etlmicity, maternal education, marital status, health insurance, parity, smoking, and birth year.

Source: Pregnancy to Early Life Longitudinal (PELL) Data, 1998–2013.

DHH, Deaf or Hard of Hearing.