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Trends in Childhood Viable Pregnancy and Risk of Stillbirth in the United States

Sahra Ibrahimi
Adelphi University School of Nursing: Adelphi University College of Nursing and Public Health

Deepa Dongarwar (deepa.dongarwar@bcm.edu)
Baylor College of Medicine https://orcid.org/0000-0002-7338-0636

Korede K. Yusuf
Adelphi University School of Nursing: Adelphi University College of Nursing and Public Health

Sitratullah Olawunmi Maiyegun
Texas Tech University

Hamisu M. Salihu
Baylor College of Medicine Chronic Disease Prevention and Control Research Center: Baylor College of Medicine

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Abstract

The objective of this study was to assess trends in childhood viable pregnancy over the previous three decades as well as the risk of stillbirth in these highly vulnerable child mothers. We conducted a population-based retrospective cohort study that used Birth datasets, Fetal Death datasets, and the US population census data: 1982-2017. To assess the association between various socio-demographic and maternal comorbidities and stillbirth, we generated adjusted hazard ratios (AHR) from Cox Proportional Hazards Regression models. Overall, there were declines in the stillbirth rates in both teens (15-19 years old) and child mothers aged ≤ 14 years, but the rate remained consistently higher among child mothers. Compared to teen mothers, childhood pregnancy was modestly associated with elevated risk for stillbirth. Childhood pregnancy is a risk factor for stillbirth. These findings further underscore the need for sustained efforts and policies to prevent pregnancies in the early years of reproductive development.

What Is Known?

Children born to teen mothers have increased risk of teen pregnancy, higher high school drop-out rates, greater chances of incarceration during their teenage years, and higher unemployment as young adults.

What is new?

Overall, there were declines in the stillbirth rates in both teens (15-19 years old) and child mothers aged ≤ 14 years, but the rate remained consistently higher among child mothers.

Introduction

Although teen pregnancy rate has decreased over the past two decades in the US, it still remains an important public health issue. [1] The teen pregnancy rate in the US is higher than in other industrialized western countries,[2] and disparities exist by race/ethnicity as well as geographic region. [3] In 2017, the overall rate of teen pregnancy among women aged 15–19 years old was 18.8 per 1,000 women, with Black and Hispanic teens having over twice the pregnancy rate of their White counterparts. [4] Pregnancy during the teenage years not only causes problems for the adolescent mother but also creates issues for the child and the society at large. Children born to teen mothers have increased risk of teen pregnancy, higher high school drop-out rates, greater chances of incarceration during their teenage years, and higher unemployment as young adults. [5]

Childhood pregnancy was previously defined as pregnancy at ≤ 14 years (1) and could be associated with a number of pregnancy complications and adverse pregnancy outcomes, including preterm delivery, low birth weight, [6-8] and infant mortality. [9,10] In the previous decades, Salihu et al. found that pregnancy in childhood was a risk factor for stillbirth in both singletons and twins. [1] The increased risk of neonatal and post-neonatal mortality among young teens has been attributed to biological immaturity. [11] Furthermore, adverse pregnancy outcomes associated with low maternal age are attributed to health predictors, including poor socioeconomic status[12] and racial disparity. [13] Low socioeconomic conditions may impact dietary habits, access to prenatal care, and cigarette smoking or other tobacco use. [12] All of these social determinants of health may increase the risk of adverse birth outcomes among child mothers. However, updated data on childhood pregnancy in the US is lacking. In this study, we examined the trends in childhood pregnancy over the previous three decades as well as the risk of stillbirth in these highly vulnerable mothers.

Methods

We conducted a population-based retrospective cohort study that used Birth dataset, Fetal Death datasets made available by the Centers for Disease Control and Prevention, the National Vital Statistics System, and the National Center for Health Statistics; and the US population census data from the United Nations. [14] The Birth dataset had data on all births occurring within the US, while the Fetal Death dataset contained information on fetal death. The information available in these datasets was extracted from the birth and death certificates, respectively. The datasets included socio-demographics, health characteristics, and maternal risk factors associated with each live birth and stillbirth. For our study, we restricted our analyses to singleton birth

within the gestational age from 20 to 42 weeks for the years 1982 through 2018 from the Birth dataset, and 1982 - 2017 from the Fetal Death data set.

Study Variables

We included the variables that were commonly available in the datasets for most of the study period. Our exposed group, childhood pregnancy, was defined as a pregnancy that resulted in singleton live birth or stillbirth among mothers ≤ 14 years of age. For our comparison group, we used mothers ages 15 to 19, whom are also referred to as adolescent mothers. [15] Our primary outcome, stillbirth, was defined as intrauterine death of a fetus at ≥20 weeks of gestation. [15] Covariates included in the study were 1) race, which was categorized as Whites, Blacks, and Others (which included all races except Whites and Blacks). We used this categorization as it was available for all years over the study period; 2) birthplace, classified as hospital, home, and others; 3) delivery method, categorized as vaginal and C-section; 4) birth attendant, classified as certified medical professional including medical doctors, nurses, midwives, etc. and others; 5) gestational age (which was measured based on the date of last menstrual period (LMP)), categorized as preterm (i.e., <37 weeks or term, i.e., ≥37 weeks); 6) maternal diabetes – the variable for diabetes was given without segregation between pre-pregnancy and gestational in the birth dataset till the year 2003, and in the fetal death dataset till 2013. So, we combined the variables to encapsulate any type of maternal diabetes; 7) chronic hypertension – the variable for chronic hypertension was changed to “pre-pregnancy hypertension” as from 2004 in the birth dataset, and as from 2014 in the fetal death dataset. Therefore, we combined the two variables and designated it as “chronic hypertension” for this study; 8) Pregnancy hypertension – the variable for pregnancy hypertension was changed to “gestational hypertension” as from 2004 in the birth dataset, and as from 2014 in the fetal death dataset. We decided to combine the two variables and called it “Pregnancy hypertension” for this study; 9) eclampsia - the variable for eclampsia was changed to “hypertension eclampsia” as from 2004 in the birth dataset, and as from 2014 in the fetal death dataset. We therefore, combined the two variables and called it “eclampsia” for this study.

Statistical Analysis

We calculated the rate of childhood viable pregnancy for each year by dividing the number of viable pregnancies (live birth and stillbirth) among girls aged ≤ 14 years by the total number of females aged ≤ 14 years in the US population. We compared these with similarly derived rates for adolescent mothers ages 15 – 19 years. This information was extracted from 1982 through 2017from the birth and fetal death datasets (numerator) as well as the US population census (denominator). Similarly, to derive the rate of childhood live birth for each year, we divided the number of live birth among girls aged ≤ 14 years by the total number of females aged ≤ 14 years in the US general population. Equivalent computation was performed for the comparison group (15-19 years old mothers). Live birth rates from 1982-2018 were computed to allow for comparison with previous studies that defined pregnancy rate using only live births. We also calculated stillbirth rates for both age groups by dividing stillbirth by the sum of live birth and stillbirth and then multiplying by 1000. The analyses involving stillbirth were restricted to the years 1982-2017 as the Fetal Death data was available only until 2017. We used joinpoint regression, which is a modeling technique, to detect the change in the rate of events over time. [16] We also calculated the average annual percentage change (AAPC) for trends in rates of viable pregnancies, live birth and stillbirth in both child and teen mothers over the study period.

We conducted bivariate analyses to uncover socio-demographic and maternal risk factors among child and adolescent mothers. We also examined the factors potentially contributing to live birth or stillbirth among children using Chi-square test that detects differences in proportion. To determine independent associations across the various socio-demographic and maternal comorbidities, including diabetes, chronic hypertension, pregnancy hypertension and eclampsia versus stillbirth, we generated adjusted hazard ratios (AHR) from Survey Cox Proportional Hazards Regression Models. In the adjusted models, we controlled for race, place of birth, delivery method, attendant at birth, gestational age, maternal diabetes, chronic hypertension, pregnancy hypertension, eclampsia; after removing missing values from all the covariates. All tests of hypothesis were two-tailed with a type 1-error rate set at 5%. Because the study was performed using publicly available de-identified data, it was approved as exempt by the Institutional Review Board of Baylor College of Medicine.

Results

We analyzed pregnancy data collected from 14,224,602 mothers over the 36-year study period. Of these mothers, 260,928 (1.8%) were child mothers aged ≤14 and 13,963,674 (98.2%) were teens aged 15-19 years old. Table 1 describes the socio-demographic characteristics of mothers in this study stratified by age, ≤14 years, and 15-19 years. Overall, most of the mothers were white (57.4%), had a term delivery (85.3%), and delivered their baby in the hospital (90.9%) through vaginal birth (55.0%). Child mothers were less likely to be white than teen mothers (40.8% versus 57.7%). Furthermore, mothers aged ≤14 were more likely to have a preterm birth than teen mothers (24.4% versus 14.5%). The prevalence of chronic hypertension (0.3%), pregnancy hypertension (3.1%), diabetes (1.8%), and eclampsia (0.3%) were very low among study participants though approximately half of the mothers (49.9%) had missing data on these select medical conditions.

Figure 1 presents temporal trends in the incidence of viable pregnancy among children and teens. From 1982 to 2017, the rate of viable pregnancy among children declined from 0.3/1000 to 0.06/1000 population, representing a drop of 80.0%. Among teens, the rate of pregnancy declined from 40.5/1000 in 1982 to 18.1/1000 in 2017, equivalent to a decline of 55.3%. The fall in the rate of pregnancy was not consistent throughout the years for both study groups. Overall, both childhood and teen pregnancy rates increased from 1982 to reach a peak around 1993. Starting in 1994, there was a consistent drop in pregnancy rates in both groups of mothers until around 2003. From 2003 to 2007, the rate of pregnancy in child mothers remained constant; however, it increased slightly among teen mothers until 2009. From 2007 to 2017, both childhood and teen pregnancy rates decreased. The patterns observed in the trends of live births among children and teens (supplemental figure 1) were very similar to those for viable pregnancies described above.

Table 2 shows the socio-demographic characteristics of child and teen mothers stratified by live birth and stillbirth. Out of the total number of births in both groups (N = 14,224,602), 0.8% (N=110,134) were stillbirth. About 3.0% (N= 3552) of the total stillbirth occurred among child mothers. The incidence of stillbirth in child and teen mothers were 14 per 1000 and 8 per 1000 viable pregnancies, respectively. Among children, the incidence of stillbirth was significantly higher among mothers of black race (1.7%) and those who had a cesarean section (3.1%). For teens, the incidence of stillbirth was also higher among mothers of other race (1.3%) and those who had a vaginal birth (1.0%). Regardless of age group, stillbirth rate was very high among mothers who had preterm birth and chronic hypertension. The risk of stillbirth among preterm fetuses of children and teen mothers were over 20 times more frequent compared with term fetuses.

Figure 2 shows the trends in stillbirth rate among childhood and teenage mothers. Overall, there was a decline in stillbirth rate in both groups from 1982 to 2017, but the rate remained consistently higher among child mothers. The stillbirth rate in mothers aged ≤14 dropped from about 14.8 to 11.0 per 1000 pregnancies, representing a 25.7% decline. Among teenage mothers, there was a 34.0% decrease from 10.0 to 6.6/1000 pregnancies.

In **Table 3**, we present the results of the adjusted Cox-Proportional hazards model for the association between demographic and health characteristics versus the risk of stillbirth. Mothers aged ≤14 were modestly more likely to experience stillbirth than teenagers (AHR = 1.09; 95% CI = 1.05-1.12). Black mothers had a 19% increased risk of stillbirth than White mothers. In addition, the risk of stillbirth was more than 4 times as high among mothers with preterm birth compared to those with term delivery (AHR = 4.25; 95% CI = 2.45-7.46). Furthermore, chronic hypertension was a significant risk factor for stillbirth. Mothers with chronic hypertension had a risk of stillbirth that was more than 5 times as great compared to those without chronic hypertension (AHR=5.82; 95% CI= 5.58-6.07). Mothers who delivered through cesarean section had a 74% lower risk of stillbirth compared to those who had a vaginal delivery (AHR=0.26; 95% CI= 0.25-0.28). Other factors significantly associated with increased risk of stillbirth included diabetes and eclampsia (P<0.0001).

Discussion

In this study, we found childhood pregnancy to be associated with greater risks for stillbirth compared to older teenagers (15-19 years). Additionally, our results suggest that young mothers with chronic hypertension and preterm birth were more likely to experience stillbirth. Although the rate of childhood pregnancy had declined over time, it had remained stable since 2016 and was an important risk factor for stillbirth. Other predictors of stillbirth in our study included vaginal delivery, preterm birth, chronic hypertension, diabetes, and the Black race.

Our results corroborate the findings of previous studies that showed similar trends in childhood and teen pregnancy and adverse pregnancy outcomes. [17-21] In contrast to most of the earlier studies in which pregnancy was defined based on live births, we also conceptualized pregnancy as the total number of live birth and stillbirths. However, it is logical that the rates in live birth will be a close approximation of the viable pregnancy rates because stillbirth is a rare occurrence. In the current study, we also observed a modestly increased risk of stillbirth among child mothers compared to teenage mothers. Recent studies also showed that a history of stillbirth was associated with an elevated risk of subsequent infant mortality. [18-20] The increased risk of stillbirth with childhood pregnancy may be explained by different physiologic processes that result in adverse birth outcomes. One of these is the biological immaturity of the young child who is still growing, which triggers fetal-maternal competition for nutrients, thereby compromising fetal growth, development, and survival as the pregnancy progresses. [21] Another factor is the social environment, which suggests that poor pregnancy and birth outcomes among teenagers are resultant effects of their disadvantaged social environment. [11,21]

We also observed a steady decline in pregnancy and stillbirth rates in both childhood and teenage groups, similar to recent reports. [4,17,19] This could be due to initiatives spearheaded by the Office of Population Affairs (OPA) at the Department of Health and Human Services (DHHS) that address social determinants of teen pregnancy, such as the use of different birth control methods and abstinence from sexual activities. [19] These efforts have led to increased access to prenatal care and have prompted attention to medical conditions during pregnancies. [4,18] Another factor is that adequate knowledge on timing of stillbirth specific risk factors may help in reducing antepartum and intrapartum stillbirth risks through close monitoring and prompt intervention. [4] Adolescents with adequate sexual and reproductive health literacy have been shown to be less likely to experience single and recurrent teenage pregnancies. [23,24]

One of the strengths of the study is that it is a US population-wide database, and the results will be minimally affected by selection biases. Despite this, the study has limitations, which include our inability to assess the contribution of certain behavioral characteristics such as illicit drug use, high-risk sexual behaviors, and sexually transmitted infection (STI) status. Another limitation of the study is our failure to provide information on the causes of stillbirth because the relevant data, as indicated on birth certificates, might not be reliable. The reliability and validity of birth certificate information differ from element to element; information on birth weight, delivery method, and insurance are more reliable than information on labor, maternal risk, or pregnancy complications.[27]

Our findings suggest that childhood pregnancy may be related to stillbirth. These findings further underscore the need for sustained efforts and policies to prevent pregnancies in the early years of reproductive development.

List Of Abbreviations

AAPC	Average annual percentage change
AHR	Adjusted Hazard Ratio
DHHS	Department of Health and Human Services
LMP	Last Mentrual Period
OPA	Office of Population Affairs
US	United States

Declarations

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Author contributions: Sahra Ibrahimi conceived the project idea, Deepa Dongarwar performed the data cleaning and data analyses, Dr. Hamisu Salihu supervised the study, All authors drafted the manuscript.

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Tables

Table 1: Socio-demographic characteristics of mothers aged ≤14 years and 15-19 years

	Total		≤14 years	15-19 years	Proportion of mothers ≤14 years
	n	%	%	%	%
Race					
White	8160692	57.4%	40.8%	57.7%	1.3%
Black	2733930	19.2%	14.3%	19.3%	1.4%
Others	3329980	23.4%	44.9%	23.0%	3.5%
Birth Place					
Hospital	12925829	90.9%	93.3%	90.8%	1.9%
Home	1151474	8.1%	5.6%	8.1%	1.3%
Others	147299	1.0%	1.1%	1.0%	1.9%
Delivery Method					
Vaginal	7819822	55.0%	60.2%	54.9%	2.0%
C-section	405863	2.9%	1.6%	2.9%	1.1%
Missing	5998917	42.2%	38.2%	42.2%	1.7%
Birth attendant					
Certified medical professional	14096495	99.1%	98.8%	99.1%	1.8%
Others	99984	0.7%	0.9%	0.7%	2.3%
Missing	28123	0.2%	0.3%	0.2%	3.2%
Gestational age					
Preterm	2092753	14.7%	24.4%	14.5%	3.0%
Term	12131849	85.3%	75.6%	85.5%	1.6%
Diabetes					
Yes	123007	0.9%	0.4%	0.9%	0.9%
No	7494370	52.7%	58.1%	52.6%	2.0%
Missing	6607225	46.4%	41.4%	46.5%	1.6%
Chronic hypertension					
Yes	38353	0.3%	0.2%	0.3%	1.5%
No	7087486	49.8%	56.3%	49.7%	2.1%
Missing	7098763	49.9%	43.4%	50.0%	1.6%
Pregnancy Hypertension					
Yes	444509	3.1%	3.7%	3.1%	2.2%
No	6833281	48.0%	53.7%	47.9%	2.1%
Missing	6946812	48.8%	42.5%	49.0%	1.6%
Eclampsia					
Yes	47812	0.3%	0.6%	0.3%	3.2%
No	7072887	49.7%	56.0%	49.6%	2.1%

Missing	7103903	49.9%	43.4%	50.1%	1.6%

Child mothers £14 years and teenage mothers 15-19 years.

Table 2: Socio-demographic characteristics of childhood mothers and stillbirth.

	Child Mothers					Teenage Mothers				
	Live Birth		Stillbirth		Incidence of stillbirth	Live Birth		Stillbirth		Incidence of stillbirth
	n	%	n	%		n	%	n	%	
Race										
White	104979	40.8%	1422	40.0%	1.3%	7991508	57.7%	62783	58.9%	0.8%
Black	115122	44.7%	2050	57.7%	1.7%	3171903	22.9%	40905	38.4%	1.3%
Others	37275	14.5%	80	2.3%	0.2%	2693681	19.4%	2894	2.7%	0.1%
Birth Place										
Hospital	240017	93.3%	3364	94.7%	1.4%	12578325	90.8%	104123	97.7%	0.8%
Home	14527	5.6%	171	4.8%	1.2%	1134707	8.2%	2069	1.9%	0.2%
Others	2832	1.1%	17	0.5%	0.6%	144060	1.0%	390	0.4%	0.3%
Delivery Method										
Vaginal	154511	60.0%	2553	71.9%	1.6%	7583432	54.7%	79326	74.4%	1.0%
C-section	4136	1.6%	134	3.8%	3.1%	400091	2.9%	1502	1.4%	0.4%
Missing	98729	38.4%	865	24.4%	0.9%	5873569	42.4%	25754	24.2%	0.4%
Birth attendant										
Certified medical Professional	254982	99.1%	2694	75.8%	1.0%	13757450	99.3%	81369	76.3%	0.6%
Others	2301	0.9%	40	1.1%	1.7%	96759	0.7%	884	0.8%	0.9%
Missing	93	0.0%	818	23.0%	89.8%	2883	0.0%	24329	22.8%	89.4%
Gestational age										
Preterm	60515	23.5%	3152	88.7%	5.0%	1942065	14.0%	87021	81.6%	4.3%
Term	196861	76.5%	400	11.3%	0.2%	11915027	86.0%	19561	18.4%	0.2%
Diabetes										
Yes	1121	0.4%	20	0.6%	1.8%	120414	0.9%	1452	1.4%	1.2%
No	149381	58.0%	2284	64.3%	1.5%	7275493	52.5%	67212	63.1%	0.9%
Missing	106874	41.5%	1248	35.1%	1.2%	6461185	46.6%	37918	35.6%	0.6%
Chronic hypertension										

Yes	500	0.2%	57	1.6%	10.2%	35629	0.3%	2167	2.0%	5.7%
No	144780	56.3%	2246	63.2%	1.5%	6874100	49.6%	66360	62.3%	1.0%
Missing	112096	43.6%	1249	35.2%	1.1%	6947363	50.1%	38055	35.7%	0.5%
Pregnancy Hypertension										
Yes	9476	3.7%	227	6.4%	2.3%	433085	3.1%	1721	1.6%	0.4%
No	137949	53.6%	2279	64.2%	1.6%	6626013	47.8%	67040	62.9%	1.0%
Missing	109751	42.6%	1246	35.1%	1.1%	6797994	49.1%	37821	35.5%	0.6%
Eclampsia										
Yes	1500	0.6%	30	0.8%	2.0%	45706	0.3%	576	0.5%	1.2%
No	143864	55.9%	2282	64.2%	1.6%	6858836	49.5%	67905	63.7%	1.0%
Missing	112005	43.5%	1247	35.1%	1.1%	6952550	50.2%	38101	35.7%	0.5%

Child mothers £14 years and teenage mothers 15-19 years.

Table 3: Cox-Proportional hazards model to assess the association between various demographic and health characteristics and the risk of stillbirth.

	Unadjusted		Adjusted	
	HR (95% CI)	p-value	HR (95% CI)	p-value
Age				
15-19 years	reference		reference	
≤ 14 years	1.86(1.81-1.93)	<0.0001	1.09(1.05-1.12)	<0.0001
Race				
White	reference		reference	
Black	1.72(1.701.74)	<0.0001	1.19(1.18-1.21)	<0.0001
Others	0.14(0.13-0.15)	<0.0001	0.38(0.37-0.4)	<0.0001
Birth Place				
Hospital	reference		reference	
Home	1.23(1.22-1.24)	<0.0001	1.11(1.01-1.21)	<0.0001
Others	1.64(1.63-1.65)	<0.0001	1.04(0.96-1.19)	0.08
Delivery Method				
Vaginal	reference		reference	
C-section	0.11(0.1-0.12)	<0.0001	0.26(0.25-0.28)	<0.0001
Birth attendant				
Certified medical professional	reference		reference	
Others	1.58(1.23-1.72)	<0.0001	1.95(1.83-2.08)	<0.0001
Diabetes				
No	reference		reference	
Yes	1.33(1.26-1.40)	<0.0001	1.95(1.85-2.05)	<0.0001
Chronic hypertension				
No	reference		reference	
Yes	6.44(6.17-6.72)	<0.0001	5.82(5.58-6.07)	<0.0001
Pregnancy hypertension				
No	reference		reference	
Yes	1.40(1.39-1.42)	<0.0001	1.34(1.33-1.36)	<0.0001
Eclampsia				
No	reference		reference	
Yes	1.39(1.28-1.50)	<0.0001	1.41(1.32-1.57)	<0.0001
Gestation				
Term	reference		reference	
Preterm	6.06(4.23-9.73)	<0.0001	4.25(2.45-7.46)	<0.0001

Child mothers £14 years and teenage mothers 15-19 years.

Figures

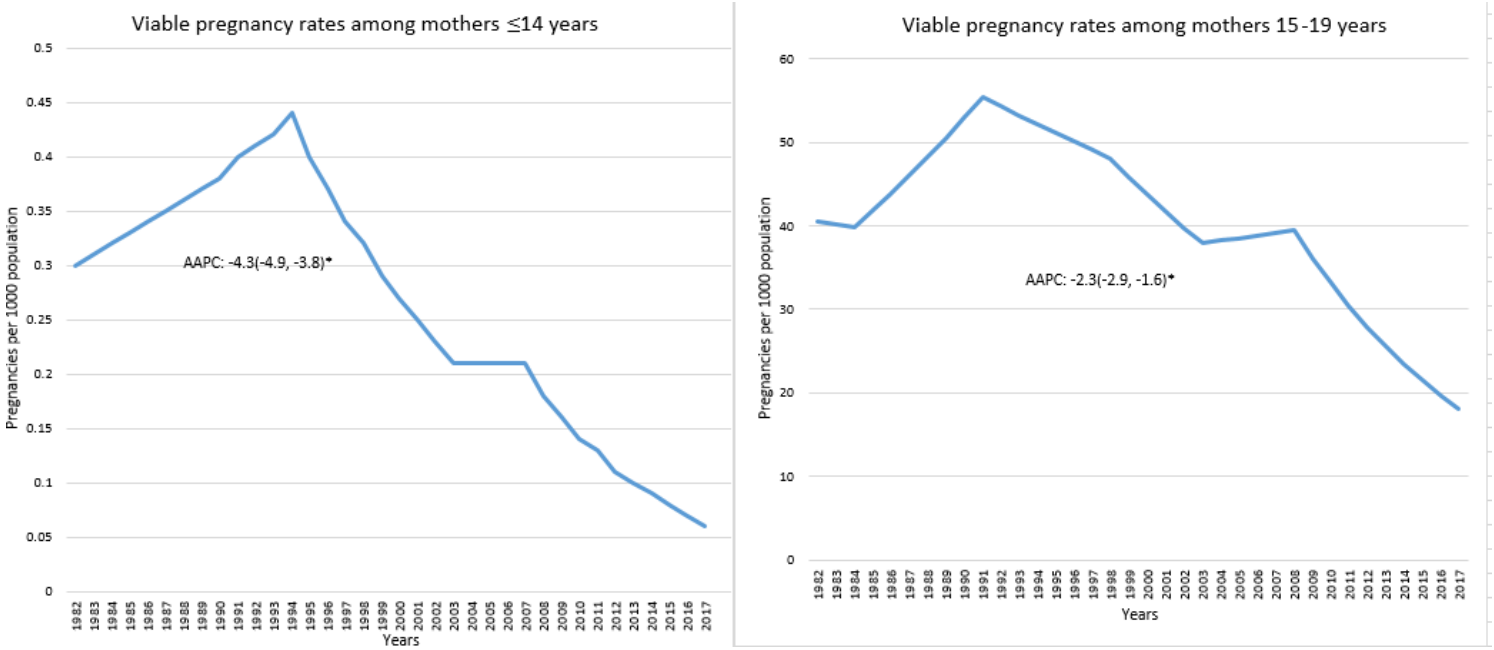

Figure 1

Viable pregnancy rates among children aged ≤ 14 years and teens aged 15-19 years

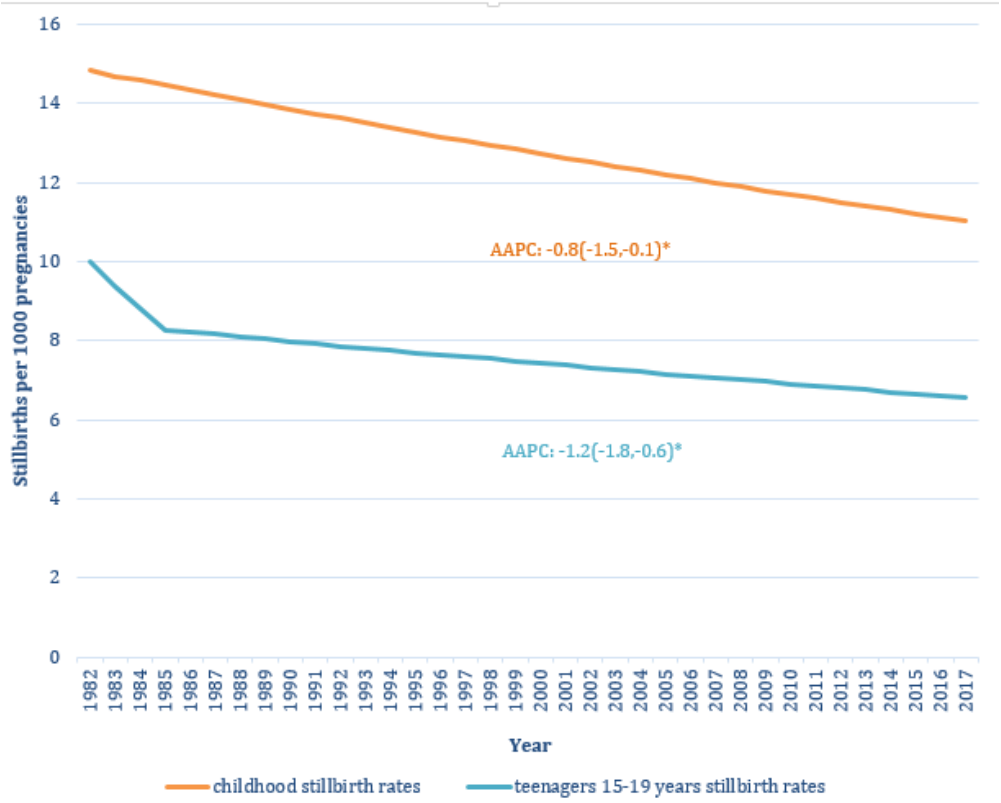

Figure 2

Stillbirth rates among childhood (aged ≤ 14 years) and teenage (aged 15-19 years) pregnancies

Supplementary Files

This is a list of supplementary files associated with this preprint. Click to download.

- SupplementalFigure1.png