Pregnancies and Pregnancy Desires at the State Level: Estimates for 2017 and Trends Since 2012

Methodology Appendix

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Acknowledgments

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Introduction

This appendix describes the methodology and data sources used to calculate the estimates presented in *Pregnancies and Pregnancy Desires at the State Level: Estimates for 2017 and Trends Since 2012*. These include estimates by state and year for three pregnancy desire groups: pregnancies wanted at the time that they occurred or sooner than they occurred; pregnancies wanted later than the time that they occurred or not wanted at all; and pregnancies characterized by uncertainty, defined as those occurring among individuals who reported that prior to their pregnancy they had not been sure whether they wanted to become pregnant. Our estimation procedure involves combining multiple data sources, each with its own strengths and limitations.

The total number of pregnancies in each state is the sum of all births, abortions and fetal losses among residents of that state. Similarly, the total number of pregnancies within each pregnancy desire group is the sum of all births, abortions and fetal losses that had been characterized by that pregnancy desire. For example, pregnancies wanted later or unwanted represents the sum of all births from pregnancies wanted later or unwanted, all abortions from pregnancies wanted later or unwanted, and all fetal losses from pregnancies wanted later or unwanted. The data sources for births, abortions and fetal losses, and distributions of pregnancy desires for each, are described below, as well as the methods we employed for calculating estimates.

Births: counts and pregnancy desires

The annual number of births occurring to residents of each state in each calendar year from 2012 to 2017 was obtained from the National Center for Health Statistics' National Vital Statistics System.[1] In instances of a multiple birth (i.e., twins and higher order births), we count each infant delivered as a single pregnancy, an approach consistent with published overall pregnancy rates by state.[2]

Data on the proportion of births in each pregnancy desire group was obtained from annual Pregnancy Risk Assessment Monitoring System (PRAMS) surveys, a surveillance project conducted by the Centers for Disease Control and Prevention (CDC) and individual states, for the years 2012–2017. PRAMS consists of annual surveys of residents who have delivered a recent live birth (respondents are typically surveyed two to six months after delivery). The sample is drawn from the state vital statistics data file containing all birth certificates and is weighted to represent those who reside in the state and delivered a live birth in the year of the survey.[3] PRAMS surveys are coordinated by the CDC and were conducted in 47 states and New York City in 2017; in earlier years, fewer states participated (39 in 2016, 40 in 2015, 40 in 2014, 40 in 2013, and 37 in 2012).[4] New York State (excluding New York City) and New York City each conduct PRAMS surveys independent of one another; we combine data from both surveys to produce estimates for New York State as a whole.

For data collected from 2012 to 2014, the CDC did not release or recommend the use of data from PRAMS surveys that did not reach a response rate of 60%; for 2015–2017, this threshold was lowered to 55%.[4] Estimates from surveys with lower-than-optimal response rates can be greatly affected by unobserved variation in who is likely to respond; because of this, we used data only from states that met CDC thresholds. This ranged from 28 to 35 states and localities for 2012–2017, with the highest number of states and localities available in 2017. (As shown in Methodology Appendix Table 1, different states met response rate thresholds each year; 42 states and New York City had data available for release for at least one year).[4]

For each state with available data, we calculated weighted proportions of births in each of the pregnancy desire response categories, as well as associated standard errors, accounting for the complex sample design of the PRAMS survey by using the *svy* commands in Stata 16.1.[5]

We then used these weighted proportions and estimated standard errors as inputs in a simple Bayesian model to estimate, for each year from 2012 to 2017, the true proportion of births in each pregnancy desire response category in each state, among all states with data available for at least one year. We estimated these proportions within a Bayesian model primarily to incorporate multiple sources of error into uncertainty intervals, and more easily propagate that uncertainty into other derived estimates (e.g., pregnancy rates according to pregnancy desire). The model has the added advantage of allowing us to better estimate proportions in each state for years without available PRAMS data because it can incorporate information from neighboring years in that state, as well as information about the relative stability of the proportion of births in each pregnancy desire category over time (see model description below). For years with available data, the model also enabled us to smooth estimates in order to be purposefully conservative in identifying potential trends except in the absence of strong evidence.

In the model, we assume that for each state, the PRAMS estimate of the proportion of respondents in each pregnancy desire response category for each year (denoted $\hat{\mu}_{jit}$, where j is the response category, i is the state and t is the year) is the realization of a draw from a truncated normal distribution with true mean μ_{jit} and standard deviation σ_{jit} (defined as the standard error of the PRAMS estimate for that response category, state and year), bounded at 0 and 1. To smooth estimates over time, as well as help estimate years for which data is not available, we model the change in μ_{ij} over time as the product of a random walk process without drift, where the difference between μ_{jit} and μ_{jit-1} is drawn from a normal distribution with mean 0 and standard error ε_{ij}.

In practice, this means that in the absence of data, the model assumes that estimates closer to the estimate for the year prior are more plausible. ε_{ij}, which describes the amount of variation over time for any given state, is state-specific. However, to help estimate the scale of variation over time for states with a limited number of years of data, we set a hierarchical prior on ε_{ij}, such that ε_{ij} is drawn from a normal distribution with mean θ_j and standard deviation Φ_j. In other words, how much the proportion of births in each pregnancy desire group changes over time is informed by the scale of these changes for the states in which we have data for multiple

years. We set a moderately informative prior [beta(1,5)] on θ_j to encourage smoothing and discourage implausibly large changes between years, and a weakly informative prior [beta(2,2)] on μ_{jit}. Finally, to ensure that the proportion of births in each pregnancy desire group sum to 1, we set a strongly informative prior [normal(1, .001)] on the sum of the proportions.

We used the posterior distributions for the proportions of births in each pregnancy desire group, as well as the posterior distribution of the proportion of abortion in each pregnancy desire group (the modelling of which is described below), to derive all other quantities described in this appendix with valid uncertainty intervals. The model was fit in Stan using the *cmdstanr* package;[6] complete model code is available on OSF at https://osf.io/fc9u6/.

Abortions: counts and pregnancy desires

For abortion counts, most but not all states conduct annual surveillance of abortions provided in the state.[7] However, in many states, counts of abortions are incomplete in state surveillance systems. In addition, for the calculation of state-specific pregnancy rates, counts of abortions obtained among state residents are needed, not the number of abortions that occurred in the state. We therefore used counts of abortions by state of residence for 2012–2017 estimated from a periodic national census of abortion providers and ancillary surveys of clinics conducted by the Guttmacher Institute, in conjunction with data on the state of residence of individuals having abortions in each state from the CDC and state-level health departments.[2]

There are currently no representative state-level data that allow for categorizing pregnancy desires among individuals whose pregnancies resulted in induced abortion (PRAMS data are limited to births). However, we do have national-level estimates of pregnancy desires among individuals obtaining an induced abortion from a periodic, nationally representative sample interviewed in the Guttmacher Institute's Abortion Patient Survey. Although the vast majority of abortions resulted from pregnancies that were wanted later or unwanted, some individuals do obtain abortions for pregnancies they reported as having occurred at the right time or later than desired (the wanted-then-or-sooner group).

Because of the lack of state-specific data that would provide the distributions of pregnancy desires among individuals having abortions, we used the national-level distributions, with some additional uncertainty incorporated into our model to account for small variations between states and over time. We modeled the observed state-specific proportions of abortions in the wanted-then-or-sooner, wanted-later-or-unwanted and wasn't-sure categories as being drawn from a truncated normal centered around the true national mean for each quantity, with the standard deviation set to the standard error plus 0.02—the latter being an estimate of how much the proportion of abortions that were from wanted-later-or-unwanted (or wanted-then-or-sooner, or wasn't-sure) pregnancies would be likely to vary between states and over time.

According to data from the 2014 Abortion Patient Survey, approximately 95% of abortions in the United States involved pregnancies that individuals wanted either later or not at all, with smaller proportions that involved pregnancies wanted then or sooner (3%) or that individuals were uncertain about (1%; proportions do not sum to 100% because of rounding). Because of the small size of the latter two groups among individuals having abortions, any variation between states is unlikely to impact overall estimates; nationally, all of these proportions have also stayed largely stable for the years for which we have Abortion Patient Survey data.

Further, the lack of data at the state level on pregnancy desires among individuals whose pregnancy ends in abortion means that we do not know how states vary in the proportion of individuals having abortions who would characterize their pregnancy as having occurred too soon and the proportion that would characterize it as having been not wanted at all. We know from PRAMS data on births that these two proportions vary considerably across states, and the same could be true among pregnancies ending in abortion. When combined, these two pregnancy desire groups—pregnancies occurring sooner than wanted and those not wanted at all—comprise the majority of all abortions in the United States, and we expect the same is true at the state level. Applying separate, national-level proportions to represent the proportion occurring sooner than wanted and the proportion unwanted across all states would impose a strong assumption that states do not vary in the distribution of such pregnancies and would have a large impact on estimates.

Fetal losses: counts and pregnancy desires

Fetal losses are often included in vital statistics reports, but they are even more undercounted than induced abortions because, for most states, only fetal deaths occurring at 20 weeks' gestation or later are required to be reported to the vital statistics system. Also, fetal loss is likely to be underreported in surveys of pregnancy histories because many spontaneous abortions occur at very early gestations and are not detected.[2] A reasonable approximation of the total number of fetal losses is the sum of 20% of all births and 10% of all induced abortions.[1,8] We applied this approximation separately for wanted-then-or-sooner, wanted-later-or-unwanted and wasn't-sure pregnancies. For example, we calculated wanted-later-or-unwanted pregnancies ending in fetal loss for each state as the sum of 20% of wanted-later-or-unwanted pregnancies ending in births and 10% of wanted-later-or-unwanted pregnancies ending in abortion to obtain the number of wanted-later-or-unwanted pregnancies ending in fetal loss in each state.

Population data

The accuracy of demographic rates depends on having accurate counts of the population. It is important to note that because the sampling frames for PRAMS and for the Abortion Patient Survey are based on birth certificates and abortion patients, respectively, they include the

population of transgender men and nonbinary people who gave birth or had abortions in 2014. Ideally, our denominator would include all people who are able to get pregnant and deliver a live birth—which would include some unknown proportion of cisgender women, some proportion of transgender men and some proportion of people whose gender is nonbinary. Because there are no reliable estimates of the population of people who are able to get pregnant, we use as a proxy the number of women of reproductive age (15–44) as measured by the Census Bureau. All rates in this report are calculated as events per 1,000 women aged 15–44 residing in the state. Following the decennial census, population counts for women residing in each state are produced by the Census Bureau in collaboration with the National Center for Health Statistics for July 1 of each year and revised periodically (the "vintage"). We used the vintage 2019 bridged-race postcensal population estimates for 2012–2017.[9]

Estimation of states without PRAMS data

For the six states where PRAMS or similar data were not available for births for any year (Arizona, Florida, Indiana, Mississippi, Nevada and South Carolina), and the two for which the pregnancy intention question used on surveys in those states differed from PRAMS surveys (California and Idaho; see below), we predicted birth rates according to desire status for the year 2017 using Bayesian multivariable linear regression models fit using the *brms* package.[10]

In the models, each of the 42 states with data represents an observation. In the first model, the dependent variable is the estimated state wanted-later-or-unwanted birth rate; in the second, the dependent variable is the estimated wanted-then-or-sooner birth rate. The remaining estimate—the wasn't-sure rate—was then obtained by subtracting the wanted-later-or-unwanted and wanted-then-or-sooner birth rates from the total birth rate for residents in each predicted state. We used information on the demographic characteristics of births in each state as predictors, selecting characteristics shown to be associated with pregnancy desires.[11–17] Our final model includes the total birth rate, the proportion of births to each of seven age groups (≤17, 18–19, 20–24, 25–29, 20–24, 35–39, and 40 and older) and the proportion of births to married people, using a regularized horseshoe prior on the covariates to limit the risk of overfitting our model to the available data.[18]

Because the dependent variables in each model—the wanted-later-or-unwanted and wanted-then-or-sooner birth rates for 2017 in 42 states with PRAMS data—were also estimated with uncertainty, we propagated this uncertainty by drawing 100 repeated samples with replacement from the posterior distributions of these rates, refitting the linear regression and predicting the missing states each time. We then combined the draws from the posterior distributions of the predicted states produced from each sample and used these combined draws to calculate 95% uncertainty intervals. We combined these predicted wanted-later-or-unwanted and wanted-then-or-sooner birth rates with data on abortions and fetal loss for each predicted state to produce wanted-later-or-unwanted and wanted-then-or-sooner pregnancy rates and the other measures presented in the report tables.

To test the accuracy of the model, we calculated predicted birth rates by pregnancy desire category in 2017 for the 42 states for which we had data, dropping one state's data from the model before prediction. We then compared the model's prediction to the actual rate for that state and category, and repeated this process for all 42 states. MA Table 2 shows the mean error and mean absolute value of the error. Prediction errors were relatively small (on average, <1.5 rate points), and without clear geographic patterns by census division.

States with PRAMS-like surveys

Two states did not participate in PRAMS in any of the years from 2012 to 2017 but administered survey programs that are based on, or are similar to, PRAMS and include questions on pregnancy desire. The Pregnancy Risk Assessment Tracking System (PRATS) survey has been administered annually in Idaho since 2001.[19] However, the PRATS survey in Idaho differed from PRAMS surveys used in other states during the analytic period in two significant ways. First, PRATS excluded mothers younger than 18, while PRAMS included all residents giving birth in the state.[20] Second, the PRATS survey used the pre-2012 PRAMS question on pregnancy desire and so does not match the format of the question used on the PRAMS surveys from 2012 to 2017.

California's Maternal and Infant Health Assessment survey has collected annual data on individuals' pregnancy desires among all births in the state since 2000. The question on pregnancy desires includes the "I wasn't sure what I wanted" answer option but does not include the "I wanted to become pregnancy sooner" response option. Because the question is not strictly comparable to the PRAMS question, we considered the Maternal and Infant Health Assessment survey data to be unavailable for our set of comparable pregnancy rates.

Limitations

•***Comparability of measures over time.*** In a detailed investigation of the potential impact of the question change on participant's responses, Maddow-Zimet and Kost concluded that estimates of unintended pregnancy using the PRAMS question on pregnancy desire, first implemented in 2012, were not comparable to those produced using the pre-2012 question and should not be used to track trends over periods of time straddling 2012.[21] Thus, this report's state-level estimates of pregnancies that are wanted later or unwanted are not comparable to the unintended pregnancy rates presented in prior publications that document trends from 2002 to 2010.[22–24] The estimates presented in this report replace the 2014 estimates in the most recently published report, *Pregnancy Desires and Pregnancies at the State Level: Estimates for 2014*, and differ slightly from the rates presented in that publication because of methodological differences in how the rates were estimated.

•***Pregnancy desires among individuals having abortions.*** The majority of abortions result from pregnancies that were wanted later or unwanted (>95%), so we were comfortable using the national distributions of pregnancy desire categories and applying these proportions to all states. However, it is likely that the proportions of pregnancies that originated as wanted later, compared with those not wanted at all, vary by state, so it is a considerable limitation that we were not able to measure this variation at the state level but necessarily relied on a single distribution measured across all states.

Our estimation of a wasn't-sure pregnancy rate and a wanted-then-or-sooner pregnancy rate also required that we use the national distribution of those characterizations of pregnancy desire from the Guttmacher Institute's 2014 Abortion Patient Survey and apply that same distribution to abortions in all states. However, the proportion of abortion patients who reported uncertainty in their pregnancy desire was relatively small (about 1%), as was the proportion reporting that they wanted to become pregnant then or sooner (about 3%). Although there may be variation across states in these proportions, their impacts on the estimated pregnancy rate are likely to be small.

It should also be noted that the pregnancy desire question on the 2014 Abortion Patient Survey is not identical to the question on the 2012–2017 PRAMS surveys. The Abortion Patient Survey uses two questions to categorize the desire status of pregnancies, while the PRAMS surveys use one. In addition, on the abortion survey, there is no response option that specifically states, "I wasn't sure what I wanted." Instead, respondents are offered the option "Not sure." We assumed that these abortions were comparable to the births categorized under "I wasn't sure what I wanted" and combined the two to estimate the wasn't-sure pregnancy rates. Some of these respondents to the abortion survey may have been reporting their feelings at the time of the survey, not prior to the pregnancy. However, we reasoned that, for those who would have selected the "I wasn't sure what I wanted" category (had it been offered), most would have chosen the "Not sure" option on the abortion survey because it would have come closest to capturing their pre-pregnancy attitude toward the pregnancy, given that, for most abortion patients, the period of time between recalling their pre-pregnancy desires and the survey (conducted at the time of their abortion) could be a matter of weeks.

•***Potential bias from misreporting of pregnancy desires.*** If respondents do not accurately report their pregnancy desires in surveys of individuals who gave birth, such as the PRAMS surveys, such misreporting could bias estimates of pregnancies characterized by pregnancy desires differentially across states.[25] In states with relatively low proportions of pregnancies ending in abortion, the misreporting could have a larger effect on the pregnancy rates than in states with higher proportions ending in abortion, assuming individuals having abortions do not misreport pregnancy desires.

•***Smoothing of estimates over time.*** For the proportion of births in each pregnancy desire group in each state, we chose to model change over time as a random walk without drift. This is a fairly conservative specification, and it resulted in a smoothing of estimates where there were sharp changes from one year to the next in the observed weighted proportions from PRAMS data, particularly in states where these weighted proportions were stable in the surrounding years. If this smoothing were too aggressive, we would risk missing or minimizing real change, which could underestimate the estimated impact of, for instance, sudden policy changes with large effects. For most states, however, the impact of smoothing was minimal. For example, for 176 of the state-year pairs with data (out of 182), there was a less than 5% difference (in all cases, less than 2 rate points) between the rate of pregnancies that were wanted later or not at all estimated by our model and the rate that would be produced by using the "raw" weighted proportion from PRAMS data. For the remaining six state-year pairs, which typically represented states where there were sharp jumps in one year, followed by a return to prevailing trends, there were slightly larger differences (from 5% to 8%). Even in those cases, however, the differences were at their largest around 2 rate points, and the increased uncertainty in the estimates are reflected in the width of the uncertainty intervals.

In addition, our model takes a particularly conservative approach to forecasting and backcasting; because we model the proportion of births in each pregnancy desire group as a random walk without drift, the model does not project trends forward or backward. For example, in cases where there is no available PRAMS data in 2017 (but there is data in prior years), the model will typically estimate the proportion of births in each pregnancy desire group as having the same mean as the closest prior year with data, but with an uncertainty interval wider than that year with data. For states with data for at least one year, we intentionally do not incorporate additional information on the demographic characteristics of births; these are only included in our separately estimated multivariable model for states where we lack any other data on pregnancy desires.

MA TABLE 1: Years of PRAMS data included in analysis, by state and New York City, 2012–2017

State/Locality	2012	2013	2014	2015	2016	2017	Total no. of years
Alabama			x	x		x	3
Alaska	x	x	x	x	x	x	6
Arizona							0
Arkansas	x	x		x	x		4
California							0
Colorado	x	x		x	x	x	5
Connecticut			x	x	x	x	4
Delaware	x	x	x	x	x	x	6
Florida							0
Georgia	x	x				x	3
Hawaii	x	x	x	x	x		5
Idaho							0
Illinois	x	x	x	x	x	x	6
Indiana							0
Iowa		x	x	x	x	x	5
Kansas						x	1
Kentucky						x	1
Louisiana				x	x	x	3
Maine	x	x	x	x	x	x	6
Maryland	x	x	x	x	x	x	6
Massachusetts	x	x	x	x	x	x	6
Michigan	x	x		x	x	x	5
Minnesota	x	x					2
Mississippi							0
Missouri	x	x	x	x	x	x	6
Montana						x	1
Nebraska	x	x	x	x	x		5
Nevada							0
New Hampshire		x	x	x	x	x	5
New Jersey	x	x	x	x	x	x	6
New Mexico	x	x	x	x	x	x	6
New York State		x	x	x	x	x	5
New York City	x	x	x	x	x	x	6
North Carolina						x	1
North Dakota						x	1
Ohio	x		x	x			3
Oklahoma	x	x	x	x	x	x	6

Oregon	x	x		x			3
Pennsylvania	x	x	x	x	x	x	6
Rhode Island	x	x	x		x	x	5
South Carolina							0
South Dakota						x	1
Tennessee	x	x	x	x			4
Texas				x	x		2
Utah	x	x	x	x	x	x	6
Vermont	x	x	x	x	x	x	6
Virginia				x	x	x	3
Washington	x	x	x	x	x	x	6
West Virginia	x	x	x	x	x	x	6
Wisconsin	x	x	x	x	x	x	6
Wyoming	x	x	x	x	x	x	6
Total	29	31	28	34	31	35	

MA TABLE 2: Mean error and mean absolute value of error from leave-one-out cross-validation of multivariable model predicting wanted-then-or-sooner and wanted-later-or-unwanted birth rates for 2017, overall and by census division

	Wanted-then-or-sooner birth rate		Wanted-later-or-unwanted birth rate	
Census division	Mean error*	Mean absolute value of error*	Mean error*	Mean absolute value of error*
Overall	-.03	1.42	.06	1.25
West	-.22	1.58	.82	1.34
Midwest	.13	1.79	-.11	1.12
South	.24	1.31	-.66	1.58
Northeast	-.44	.90	.48	.69

*Calculated as the difference between the point estimate of the predicted rate (the median of the posterior distribution) and the point estimate of the rate estimated from PRAMS data.

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