DEMOGRAPHIC RESEARCH
A peer-reviewed, open-access journal of population sciences

DEMOGRAPHIC RESEARCH

VOLUME 49, ARTICLE 15, PAGES 385–422
PUBLISHED 31 AUGUST 2023
http://www.demographic-research.org/Volumes/Vol49/15/
DOI: 10.4054/DemRes.2023.49.15

Research Article

Adolescence in flux: Unmasking 30 years of change in subnational parity-specific adolescent fertility in Mexico

Ann Garbett

Sarah Neal

Angela Luna Hernandez

Nikos Tzavidis

Contents

Demographic Research: Volume 49, Article 15
Research Article

Adolescence in flux: Unmasking 30 years of change in subnational parity-specific adolescent fertility in Mexico

Ann Garbett[1]

Sarah Neal[2]

Angela Luna Hernandez[2]

Nikos Tzavidis[2]

Abstract

BACKGROUND
In 2015 Mexico set a goal to halve its adolescent fertility rate and eliminate childbearing among girls 14 years and younger, but the ambitious goal is severely off track. National estimates show stagnation, and while implementation is targeted at the municipal level, little is known about adolescent fertility in Mexican municipalities.

OBJECTIVE
This study estimates trends in subnational parity-specific fertility from 1990 to 2020 at all adolescent ages in 2,469 Mexican municipalities. Importantly, the estimates include the fertility of younger adolescents, and parity progression ratios offer a more accurate picture of the true risk of repeat adolescent childbearing.

METHODS
This study uses pooled census data and multilevel logistic regression models to estimate age- and parity-specific municipal population proportions. Modeled estimates are used to calculate second birth parity progression ratios.

RESULTS
The analysis reveals that municipal trends see considerable diversity and change. The results unmask 30 years of flux and a surprising pattern of convergence in first births alongside little concordance for second births.

CONTRIBUTION
Not only have the estimates not been seen before, but they (1) highlight priorities that

[1] Department of Social Statistics and Demography, University of Southampton, United Kingdom.
Email: anngarbett@gmail.com.
[2] Department of Social Statistics and Demography, University of Southampton, United Kingdom.

might otherwise be overlooked by the national strategy and (2) emphasize the value of tracking first and second adolescent births separately. Ultimately, the findings have relevance far beyond Mexico. They confirm the importance of examining subnational patterns for understanding adolescent childbearing and question the adequacy of $ASFR_{15\text{-}19}$ as the default measure given that repeat births to adolescent mothers as well as births to girls before age 15 remain widespread across the globe.

1. Introduction

In 2015 Mexico launched a national initiative to reduce adolescent fertility – the first of its kind in the country. By 2030, the strategy aims to eliminate births to girls 14 years and younger and halve the number of births to adolescents 15 to 19 years old (CONAPO 2015). In concrete terms, this means achieving a rate of 0 births per thousand adolescents aged 10 to 14 years and 32.9 births per thousand adolescents aged 15 to 19 years, hereafter referred to as $ASFR_{15\text{-}19}$ (age-specific fertility rate for women aged 15 to 19 years) (CONAPO 2015). However, official forecasts project an $ASFR_{15\text{-}19}$ of 62.2 births in 2030 (CONAPO 2018b). Without a dramatic intensification of the pace of decline, the goal is not achievable.

Impetus for the initiative comes from concern about high rates and limited decline over recent decades. Mexico's most recent $ASFR_{15\text{-}19}$ of 68.5 births is above the regional average for Latin America and the Caribbean of 63 births and far exceeds the average for upper-middle income countries of 30 births (UN Population Division 2019). Furthermore, recent declines are modest compared to those of the past. From 1950 to 1990, Mexico's $ASFR_{15\text{-}19}$ fell by an average of almost 16 births per decade (149.5 to 86.1 births). Since 1990, the rate has fallen by less than 6 births per decade (86.1 to 68.5 births) (CONAPO 2018b).

Strategy documents for Mexico's multisectoral initiative target implementation by municipality, the country's smallest administrative unit, and prioritize those municipalities with the highest $ASFR_{15\text{-}19}$ and largest population size (Gutiérrez et al. 2015). However, because there are no official municipal estimates of fertility at ages 14 years and younger, tracking progress toward its elimination is difficult. Additionally, there are no official municipal estimates of parity-specific fertility even though a growing body of evidence suggests that first and repeat adolescent births see different trends, arise from different causes, and require distinct interventions (Garbett, Perelli-Harris, and Neal 2021; Hindin et al. 2016). A better understanding of age- and parity-specific subnational trends may help break the apparent stalemate by offering more targeted prioritization.

This study uses multilevel regressions to estimate trends in municipal parity-specific fertility from 1990 to 2020 at all adolescent ages. Importantly, this study's parity-specific estimates include the fertility of the youngest and its parity progression ratios more accurately measure the true risk of repeat adolescent childbearing.

The results are surprising. They unpack the national-level stagnation into a complex array of subnational flux that varies considerably by age and parity. Ultimately, the findings have relevance far beyond Mexico. First, the Sustainable Development Goals recognize that addressing adolescent fertility (Indicator 3.7.2) is an essential component of global efforts to ensure healthy lives and promote well-being for all at all ages (Goal 3) (UN General Assembly 2017). Second, the complexity of the results confirms the importance of examining subnational patterns, rather than relying on national averages, for tackling adolescent childbearing. And third, the parity-specific differences have meaning for the broader debate about the adequacy of $ASFR_{15\text{-}19}$ as the default measure of adolescent childbearing given that repeat births to adolescent mothers as well as births to girls before age 15 remain widespread across the globe (UNFPA 2022).

2. Background

To set the scene for why Mexico offers a compelling case study, the following paragraphs explore the country's demographic landscape. Decades of economic and political stability, a strong health system, and an impressive schooling expansion, despite underlying inequalities, mean the country's apparently immobile adolescent fertility remains a puzzle. A review of why municipalities, rather than states, offer a more useful geography for subnational trends follows alongside an exploration of why examining age- and parity-specific change, rather than $ASFR_{15\text{-}19}$, holds promise.

2.1 Context

Mexico is currently the second most populous country in Latin America and the tenth most populous country in the world (UN DESA 2022). While Mexico's total population grew from 81 million in 1990 to 128 million in 2020, the size of the country's adolescent female population changed relatively little, only increasing from 10 to 11 million (UN Statistics Division 2021). In some respects, the Mexico of 1990 to 2020, or the 30 years covered by this study, is marked by stability and prosperity for adolescents.

At the national level, Mexico saw solid educational achievements both prior to the 1990s and thereafter. Free universal primary schooling was established in Mexico's 1917 constitution (Diario Oficial 1917), but it was not until the 1960s that the first nationally coordinated effort to expand primary education began, and only in the late 1990s did it become universal (Mier y Terán and Rabell Romero 2003). From 1990 to 2020, net enrollment in primary schooling remained practically unchanged with between 97% and

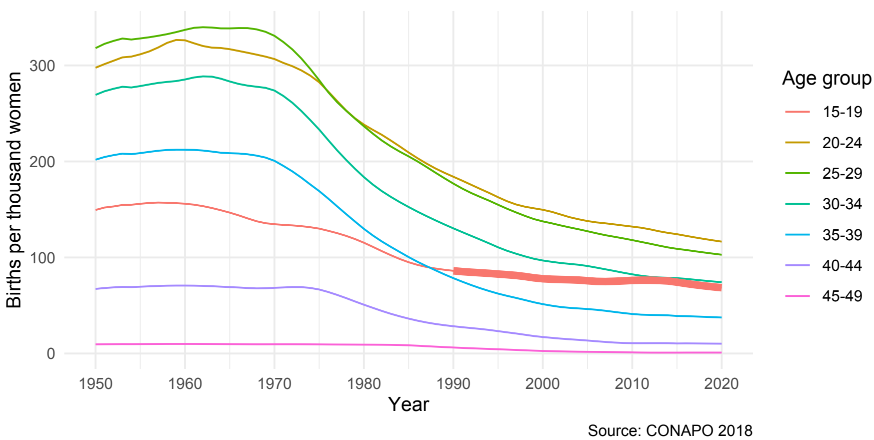
98% of children aged 6 to 11 years enrolled in the normative level corresponding to their age (INEGI 2022b). In the 1980s, the approaching realization of universal primary education and a stable youth population underpinned government efforts to expand lower secondary schooling, which was added to the mandatory schooling cycle in 1993 (Diario Oficial 1993; Mier y Terán and Rabell Romero 2003). From 1990 to 2020, net enrollment in lower secondary grew from 50% to 84% among adolescents aged 12 to14 years (INEGI 2022b). Upper-secondary schooling, in contrast, was added to the mandatory education cycle only in 2013 (Diario Oficial 2012), and net enrollment increased from 23% to 62% among 15 to 17-year-olds over the same period (INEGI 2022b). However, the country's history of educational expansion, in broad terms, prioritized the more populated and economically advanced areas of the country, with rural and indigenous communities following far behind (Binder and Woodruff 2002; Mier y Terán and Rabell Romero 2003). As such, measures of schooling attainment, particularly in access to secondary and tertiary schooling, look very different at the micro level.

The economic and political picture of the 1990–2020 period is also noteworthy. Though economic growth was in many ways slower and more unequal than anticipated, growth was solid nonetheless; Mexico currently boasts the world's fifteenth largest economy in terms of gross domestic product (GDP) (Moreno-Brid and Ros 2009; World Bank 2021). Even with several smaller financial crises and recessions, the period differs sharply from the economic turmoil of the 1980s (Remmer, K 1991). However, unlike an advancing GDP, measures of poverty show entrenched vulnerabilities. National indicators of multidimensional poverty in 2020 identify that about a sixth of the population experienced extreme poverty, and just under half experienced some form of vulnerability either from limited income or limited access to social services. These proportions are little different from those at the beginning of the 1990s (CONEVAL 2020, 2022).

Despite Mexico's considerable achievements in the health arena both before and after the 1990s, fertility change has been slow to translate to the adolescent context. The first national family planning program of 1977, which was the most progressive and ambitious in Latin America, marks the beginning of the country's dramatic fertility transition, as seen in Figure 1. Successive governments maintained a strong commitment to family planning and successfully shifted from foreign funding to internal financing (Ward, Santiso-Gálvez, and Bertrand 2015). Over the course of a few generations, the country's total fertility fell from nearly seven children to two children per woman (UN Population Division 2020). However, declines in adolescent fertility did not keep pace, and there remain other mismatches. Specifically, when compared against other age groups, the change in $ASFR_{15\text{-}19}$ is surprisingly undramatic, particularly since 1990 (in bolded red in Figure 1). Additionally, although the prevalence of contraceptive use among adolescents has increased, in 2014, modern contraception was used in just under half of first sexual encounters, just as it was regularly used by just under half of sexually active adolescents (Hernández, Muradás, and Sánchez 2015). Mexico today sees a heavy reliance on female sterilization – a method ill-suited to adolescent contraceptive needs – with recent surveys indicating that just over half of contracepting women use sterilization (INEGI 2018).

In summary, dramatic fertility changes in the country have largely sidestepped adolescents, which at first glance is puzzling given the sweeping schooling expansions and economic prosperity and political stability of the 1990–2020 period. Below the surface, deep inequalities present a different picture.

Figure 1: Mexico's age-specific fertility rates from 1950 to 2020



2.2 The case for municipal fertility estimates

Existing subnational estimates hint at a much more complex story than what is seen in the national stagnation in adolescent fertility, but studies focus almost exclusively on the country's 32 federal entities (Mexico City and 31 states). Nevertheless, there is diversity. For example, although Mexico City's $ASFR_{15\text{-}19}$ sits consistently below all states, it saw an increase from 44.3 to 47.8 births from 1990 to 2020. An exceptionally large increase occurred in Nuevo León, a northern border state, with its $ASFR_{15\text{-}19}$ increasing from 44.3 to 62.6 over the same period. Meanwhile, Chiapas, a southern border state, saw its rate decline from 130.0 to 84.9 births (CONAPO 2018b, 2021).

Recall that the national initiative targets implementation at the municipal level. The first official municipal estimates – for years 2010, 2015, and 2020 – were only recently released (CONAPO 2020, 2021). We find only two sources that explore municipal trends in $ASFR_{15\text{-}19}$, both gray literature (Ailines Genis 2018; Meneses and Hernández 2019). Despite examining only recent years, these sources bring out valuable insight not seen in other analyses. Importantly, the densest concentration of municipalities with high $ASFR_{15\text{-}19}$ are not always in the states with the highest rates. Additionally, a much larger portion of municipalities have seen increasing rates compared to states. Finally, some municipalities appear to have already met the 2030 goal while others see a rate that is more than six times the target. Given the diversity, a longer-term analysis can better highlight priorities.

Despite its focus on state-level estimates, another relevant source examines fertility trends in adolescents 14 and younger (Meneses and Ramírez 2018). The findings indicate that early adolescent fertility has increased in almost all states over the last two decades. Additionally, childbearing has become increasingly concentrated among 14-year-olds, with displacement away from those 13 and younger. There is an urgent need to better understand municipal trends in early adolescent fertility in Mexico.

2.3 The case for parity-specific estimates

In turning to parity-specific trends, rather than $ASFR_{15\text{-}19}$, the adolescent fertility picture becomes even more dynamic. The proportion of women entering motherhood in adolescence has seen very little change over the last half century. About a third of women enter motherhood in adolescence – both today and 60 years ago (Garbett 2022). As such, declines in $ASFR_{15\text{-}19}$ in Mexico are the result of declines in second and higher-order births to adolescent mothers, as is the case elsewhere in the region (Neal et al. 2018). The same pattern exists in early adolescent fertility in Mexico: In 1990, 20% of births to adolescents 14 and younger were non-first births, and in 2016, only 1% of births were (Meneses and Ramírez 2018).

A parity-specific focus also has policy relevance. Despite the absence of parity-specific adolescent fertility estimates, Mexico's initiative acknowledges that approaches for reducing adolescent fertility are in fact highly parity dependent (CONAPO 2015). For example, the strategy discusses how healthcare providers can introduce adolescent mothers to more reliable contraception during health visits, and municipalities are encouraged to expand contraceptive uptake among adolescent mothers via interfaces with the health system. In contrast, the strategy acknowledges that childless adolescents face considerable social and cultural barriers to contraceptive access and use. It suggests broaching these barriers by improving comprehensive sexuality education in schools, running media campaigns to counter entrenched stigmas, and expanding youth-friendly health services. Without parity-specific municipal estimates, Mexico's national strategy has no guidance on what locations need more or less of one approach or another, and when resources are limited, as is the case here, cost-effective targeting is imperative.

3. Data

This study estimates and examines municipal age- and parity-specific adolescent fertility trends with pooled census data from 1990, 2000, 2005, 2010, and 2020 (INEGI 2022a).

3.1 Data preparation

Variables of interest include the census year, municipality of census enumeration, and age and number of children ever born. Mexico's short-form census questionnaires, which are asked at every household, include individual fertility questions for all females aged 12 and above. As such, selected individuals are all females aged 12 to 20 years old given that adolescents aged 10 and 11 years were not asked fertility questions, and though females aged 20 years old are technically no longer adolescents, including them in the analysis improves estimation of the shape of the adolescent fertility age schedule. The number of cases per census range from 8,991,447 girls in 1990 to 9,735,416 in 2020, for a total pooled dataset of just over 47 million cases (47,209,907).

While individual data from the full censuses are not openly accessible, interactive online tabulations produce the exact number of adolescents within each municipality at each individual age according to their reported number of births. An indicator of first births was derived from the number of females aged 12 to 20 reporting one or more live births as opposed to no live births. An indicator of second births was derived from the number of females reporting two or more live births. Nonresponses were coded as no births. A total of 6.7% of adolescents in the pooled data had missing data on births, with younger adolescents more likely to have missing responses than older adolescents in all census years. Additionally, missingness varied by census year, with a total of 16.8% in 1990, 4.5% in 2000, 9.8% in 2005, 2.9% in 2010, and 0.3% in 2020 of adolescents missing data on births.[5] Finally, the 2020 census coincided with the COVID-19 pandemic. While the initial enumeration phase was carried out without interruption, subsequent verification phases where considerably altered and prolonged to accommodate pandemic lockdowns and restrictions, which may affect the quality of the data (INEGI 2020a).

A few data transformations facilitated the speed of computation without altering their statistical meaning in any way. Age and census year were standardized to bring all values into the range of –1 and 1 while preserving their relative distance from each other. Prior to standardization, the integer ages were first respecified to the midyear point. For example, age 12 was respecified as 12.5, under the assumption that birthdays of all 12-year-olds in the dataset are evenly spread throughout the year such that 12.5 is the true average age of the 12-year-old sample. This specification takes additional meaning later

[5] An alternate specification that removed cases with missing fertility data estimated marginally higher proportions but did not otherwise change the broad patterns in the models.

in the study when the models are used to estimate adolescent fertility at the tail ends of early (age 14.99) and late adolescence (age 19.99). Ultimately, the standardization means that age 14.99 and 19.99 take the values of –0.3775 and 0.8725 (given that 12.5 and 20.5 are respecified as –1.0 and 1.0), while 1990 and 2020 take the values of –1.0 and 1.0, respectively.

3.2 Data quality

Census data face a number of data quality issues that produce uncertainty. For example, individuals answering the household's census questionnaire either may not know or may declare an incorrect fertility response for an adolescent or may misstate the adolescent's age. Nonresponses on fertility questions introduce additional uncertainty, as does undercoverage in census data collection. While the estimated census coverage at the national level is high, ranging between 96% to 99%, coverage in individual municipalities can reach much lower levels – with a few municipalities below 60% coverage and many at 70% and 80% (INEGI 1990, 2000, 2005, 2010, 2020b).

Additionally, there is an outstanding debate about whether census or vital statistics lead to more accurate estimates of adolescent fertility in Mexico. Research that estimates state-level trends in births to adolescents 14 years and younger preferred vital statistics because census data produced lower estimates (Meneses and Ramírez 2018) – a pattern seen elsewhere in the region (Alvarez Castaño 2015).

Mexico's official municipal $ASFR_{15\text{-}19}$ estimates use vital statistics in a first step, before reconciling them to census-based estimates in a second step (Ailines Genis 2018). The number of births, the numerator, comes from a reconstruction of vital registration records. The estimates consider births recorded to have occurred in a given year but reported up to four or seven years after the year of interest, depending on the degree of underutilization of the registry in the state. Where a full 7-year reconstruction is not possible, linear regressions project missing numbers. The denominator for the estimates, or the number of adolescents, comes from census-based population projections. Therefore, Mexico's official $ASFR_{15\text{-}19}$ estimates are not independent of census data.

This means that vital-statistics data also have their drawbacks, particularly that not all births are recorded. It can often take several years for some of the more disadvantaged mothers, particularly the youngest mothers, to register their births. Additionally, any undercounting in census-based total adolescent populations could produce overestimated rates when using vital-statistics numerators. Ultimately, this study prefers census data so that all variables in the analysis come from the same source.

Also note that this study's estimates reflect the de jure residency of the population. That is, the censuses enumerate individuals where they usually reside regardless of where they are on the census day. This means the data reflects the adolescent population residing within municipalities at the time of the census, as opposed to where the adolescents were born or where they might have given birth. As such, they do not disentangle how patterns of migration influence the municipal adolescent fertility estimates. Historically, internal migration in Mexico saw movements from rural to urban locales and from the poorer south to the better-off north. More recently, migration in Mexico is more about urban-to-urban movement (Pérez-Campuzano and Santos-Cerquera 2013). An average of 8% of cases in the dataset resided in a different municipality at the time of the census compared to five years previous. Data explorations that looked at parity-specific estimates among migrants compared to nonmigrants found differences to be minimal.

4. Methods

Mexico's national initiative focuses on $ASFR_{15\text{-}19}$, or the number of births per thousand adolescents aged 15 to 19 years, but this study models age- and parity-specific municipal probabilities. See the introductory sections for the rationale, and note that the estimated probabilities are referred to as proportions throughout this study. The way these fertility measures are interrelated is explored in the final paragraphs of the results.

Childbearing proportions for any given census year can be calculated from the full census data directly, but this study uses regression models for the following reasons: (1) to smooth out natural variations by age and year to be able to say something about overarching trends over time (including projecting future trends); (2) to obtain estimates for fractional periods via interpolation, such as for ages or municipalities that are missing observations in any given census year (e.g., age 14.99 and 19.99); and (3) to make inferences that account for the fact that the census data are just one fleeting snapshot of the theoretical population of interest.

To estimate the proportion of adolescents in each municipality with a first and second birth in both early and later adolescence from 1990 to 2020, this study uses two separate logistic multilevel models: one for first births and another for second births. For a deeper analysis of patterns of second births, we present parity progression ratios. That is, we use the estimated first and second birth proportions to compute the proportion of adolescents with a first birth who go on to have a second in adolescence. Ages 14.99 and 19.99 are of particular interest because they capture the proportions with births at the end of early and late adolescence.

It is worth emphasizing that progression ratios more correctly account for the true risk of a second birth. To illustrate, two municipalities may share the same proportion of adolescents with two births – say 10% – but this means something very different if the two municipalities have different proportions with first births. If one municipality sees 20% of 19.99-year-olds with a first birth, that means a full 50% of the population at risk had a second birth. In contrast, if the other municipality sees 40% of 19.99-year-olds with a first birth, that means 25% of the population at risk had a second birth. That is, even though the proportions with second births are the same, the likelihood is twice as high in the first municipality as it is in the second.

We use multilevel models because they provide a more correct approach to statistical inference by accounting for possible correlation in observations belonging to the same municipality, which would violate the independence assumption of standard regression. Furthermore, the models involve common regression coefficients across municipalities and time as well as municipality-random effects, which represents a more efficient use of the data and leads to less noisy estimates when observation numbers are limited. This is important because some municipal age and parity combinations have few cases despite the use of census data. It also allows us to obtain estimates for municipalities with missing data, particularly the 101 municipalities created after 1990. Specifically, because multilevel models do not assume an equal number of occasions or fixed time points across all observations, the models are able to estimate municipal regression coefficients – even for these new municipalities – using whatever years the municipalities have census data available. Additionally, potential problems from missing data are ameliorated because year and age are modeled as continuous variables in the multilevel models, which means the patterns of the effect of those two variables are determined by the whole set of observations, not just those corresponding to a particular year or age.

As a drawback, estimates obtained using this methodology may suffer from shrinkage, wherein estimates are pulled toward the average across all municipalities in a degree that depends on the number of observations and the distinctiveness of the observed values within each group (Goldstein 1997). Given the use of census data in this application, and hence the large number of observations, we do not expect this to be a concerning issue.

Refer to this study's online supplementary material for more on the uncertainty in the models and maps of municipal standard errors. The supplementary material also provides a list of all parity-specific municipal estimates at ages 14.99 and 19.99 (both model-based and census-based). Ultimately, although this study's results identify and discuss the exact point estimates produced by the models, these should be interpreted with caution. Given the limitations of census data (reviewed previously) and the methodological strategy used, the estimates are more likely to underestimate than overestimate the incidence of adolescent fertility.

For this study, the multilevel models were estimated in R using the package lme4 (Bates et al. 2015), which uses a procedure that optimizes a function of the log-likelihood using penalized iteratively re-weighted least squares. The log-likelihood is evaluated using the Laplacian approximation. The outcome variable in the modeled data was the proportion of adolescents with a first or second birth, respectively, at a given age and census year within a given municipality as indicated in the census data, with model weights set to the total number of adolescents at each respective age and census year within the municipality.

Model testing identified that multilevel models provided a better fit than single-level models of first and second births, confirming that the incidence of adolescent fertility is similar for women residing in the same municipality but differs considerably across municipalities. Testing also preferred both age and time modeled with quadratic terms. The nonlinear component of change over time (i.e., the speed of increase or decrease of fertility and differences across the fertility age schedule) showed important differences across municipalities and as such were modeled using random effects as well. The final models are represented as

$$\begin{aligned}\log\left(\frac{\pi_{ij}}{1-\pi_{ij}}\right) =& \beta_0 + \beta_1 \mathrm{age}_{ij} + \beta_2 \mathrm{age}^2_{ij} + \beta_3 \mathrm{year}_{ij} + \beta_4 \mathrm{year}^2_{ij} + \\ & u_{0j} + u_{1j}\mathrm{age}_{ij} + u_{2j}\mathrm{age}^2_{ij} + u_{3j}\mathrm{year}_{ij} + u_{4j}\mathrm{year}^2_{ij}.\end{aligned} \tag{1}$$

In this model, π_{ij} is the probability of adolescent i in municipality j to have a first or second birth in adolescence, respectively. The intercept β_0 is shared by all municipalities while the random effect u_{0j} is specific to municipality j. Random effects are assumed to follow a normal distribution with variance σ^2_{u0}. Note that due to the standardization of the variables, the intercept also implies an age of 16.5 and year 2005.

In the final models, the random effects take account of all unobserved differences in municipalities, after accounting for age and time, which might arise out of a host of possible causes (such as differences in schooling levels or patterns of union formation). Multilevel models have the advantage of being able to incorporate observed differences when they are known, and sometimes these additional predictors are used to improve model estimates. In other instances, they are used to determine how much of the unobserved differences can be explained by known differences. The analysis here deliberately leaves out other municipal-level predictors for two reasons. First, official municipal $\mathrm{ASFR}_{15\text{-}19}$ were derived without adjustments from other variables and used only individual indicators for age and time (CONAPO 2020). Second, existing research finds an inconsistent relationship between various socioeconomic indicators and adolescent fertility in Mexico at both the individual and aggregate level (Ailines Genis 2018; Flórez 2005; Velarde and Zegers-Hochschild 2017). As such, including such indicators in the models may confuse rather than improve the estimated proportions.

Finally, predictions for Mexico as a whole were obtained by calculating the mean of the municipality proportions weighted by their population size. The weighting is necessary in multilevel logistic models – unlike in multilevel linear models, where population-level predictions can be obtained simply by ignoring the random effects – because of the nonlinearity of the logit means that random effects also contribute to population-level predictions. The 2030 prediction for Mexico assumes relative municipal adolescent population sizes remain identical to those observed in 2020.

5. Results

Not only do the multilevel models produce adolescent fertility estimates that, to the best of our knowledge, have not been seen before, they also offer the potential for improved intervention targeting. Table 1 presents the regression results, but the following paragraphs will focus on the fitted values. The fitted values were obtained by inputting the regression coefficients into model equation 1 (shown previously) at the year and age of interest. Rather than show all 2,649 coefficients for each of the random effects (specific to each municipality), the table instead summarizes these values, as per convention, with their variance and standard deviation. A full list of municipal fitted values is given in the online supplementary material.

Table 1: Multilevel regression model results

	First births		Second births	
	Regression coefficient	Standard error	Regression coefficient	Standard error
Fixed effects				
Intercept	–2.997	0.008	–5.236	0.011
Age	3.673	0.007	3.830	0.018
Age^2	–1.165	0.005	–0.532	0.014
Year	–0.069	0.005	–0.487	0.006
Year^2	–0.017	0.005	–0.003	0.006
	Variance	Standard deviation	Variance	Standard deviation
Random effects				
Intercept	0.158	0.398	0.195	0.441
Age slope	0.041	0.202	0.287	0.535
Age^2 slope	0.016	0.128	0.169	0.412
Year slope	0.040	0.201	0.063	0.252
Year^2 slope	0.050	0.224	0.046	0.214
Observations	109,978		109,978	
Groups (municipalities)	2,469		2,469	
Log-likelihood	–247,010		–156,527	

Note: Age and year are standardized variables.

Particular attention will be given to municipalities with noteworthy trends that might otherwise be overlooked by the current strategy that prioritizes municipalities with the highest $ASFR_{15\text{-}19}$ and largest populations. Refer to the supplementary material for a detailed list of municipal estimates.

5.1 First births in adolescence

Figure 2 depicts the 2020 municipal estimates of the proportion of adolescents with a first birth at ages 14.99 and 19.99, two age points chosen for their relevance to Mexico's national initiative to eliminate childbearing at ages younger than 15 and halve childbearing among older adolescents.

For Mexico as a whole, model estimates indicate that 26.8% of all 19.99-year-olds and 0.9% of 14.99-year-olds had given birth in 2020. In other words, about 1 in every 4 girls entered motherhood in adolescence while 1 out of every 100 girls entered motherhood before the age of 15 in 2020.[6] Municipal proportions showed considerable diversity, and the maps in Figure 2 organize the range by quintiles. According to the results, municipalities saw between 4.3% and 60.4% of 19.99-year-olds with a first birth. Among 14.99-year-olds, as few as 0.2% and up to as many as 3.7% had a first birth.

Regional clustering indicated that the periphery regions of the north, south, and coasts tended to see the highest incidence while the central regions tended to see the lowest. All but seven states had pockets of the highest quintile of adolescent fertility, and municipalities across states were often more alike than municipalities within the same state. That is, mirrored patterns in border municipalities often created corridors of high fertility alongside cross-state corridors of lower fertility. Nevertheless, there are similarities within states despite the fact that the model did not include a specific state component. (States are outlined in black.)

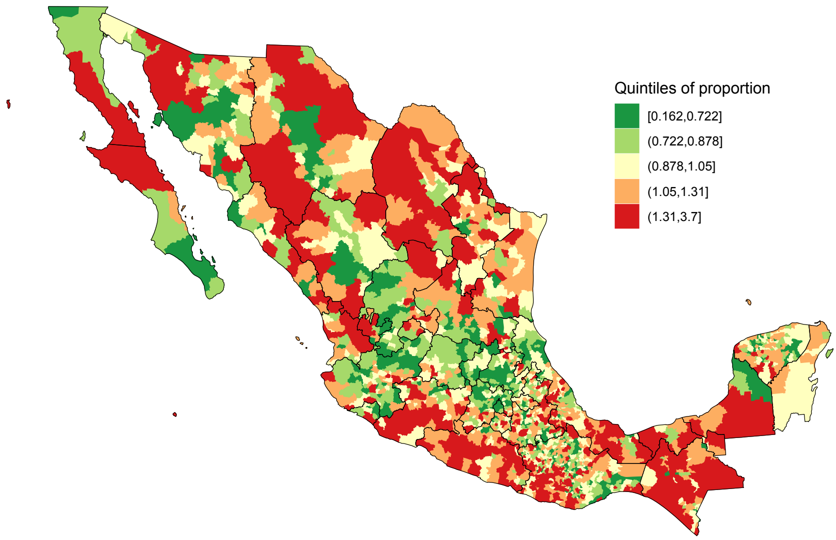
Municipalities with above-average fertility at both age points are obvious locations for prioritization, but there are other noteworthy candidates. For example, municipalities with atypical age schedules where childbearing at the youngest ages was uncharacteristically high – with 154 municipalities (6%) seeing a high incidence of early adolescent fertility (in the middle or top two quintiles at age 14.99) alongside a lower incidence of later adolescent fertility (in the bottom two quintiles at age 19.99). Importantly, the diversity of fertility age curves is such that nearly 40% of municipalities did not share the same quintile at both age points.

In looking at change over time, the picture transforms rather dramatically. The maps in Figure 3 depict the percentage point difference in first birth proportions in 2020 compared to 1990, organized into quintiles. In the figure, negative numbers indicate the municipal proportion declined from 1990 to 2020 while positive numbers indicate the proportion increased. Municipalities saw the proportion of 14.99-year-olds with a first birth decline by up to 6.1 percentage points or increase by up to 1.1 percentage points. Meanwhile, the proportion of 19.99-year-olds with a first birth declined by up to 35.1 percentage points or increased by up to 23.2 percentage points.

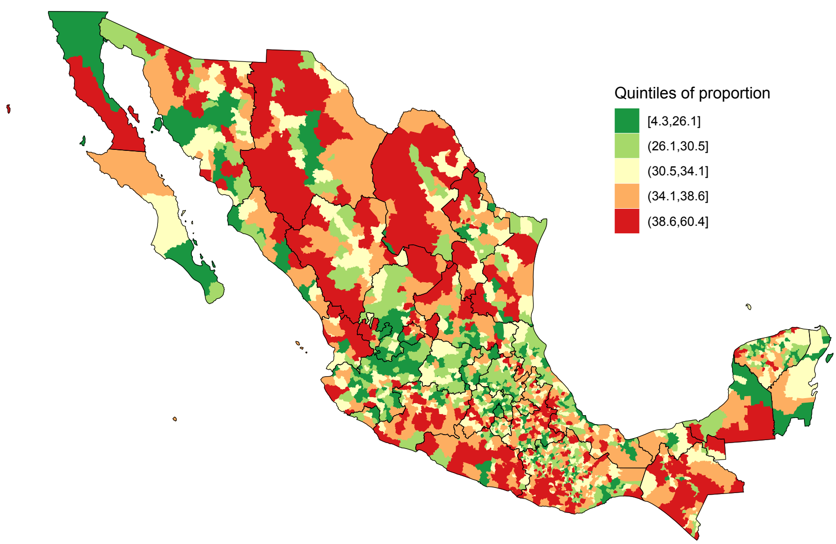
[6] Census proportions were 21.6% for 19-year-olds and 29.7% for 20-year-olds (effectively ages 19.5 and 20.5), and 0.4% for 14-year-olds and 1.4% for 15-year-olds (effectively ages 14.5 and 15.5).

Figure 2: Proportion of adolescents in Mexican municipalities with a first birth by ages 14.99 and 19.99 in 2020

(a) by age 14.99



(b) by age 19.99



Patterns are almost a mirror image of the 2020 percentages: Municipalities with the greatest increases over time tend to cluster in the center and north of the country, while patterns of decline cluster in the peripheries. This means that many of the central municipalities with the lowest proportions in 2020 experienced an increasing incidence of adolescent motherhood, while many southern municipalities with the highest incidence in 2020 experienced the most decline, even though many northern municipalities with the highest first birth proportions in 2020 also saw an increasing incidence of adolescent first births. In effect, there was a pattern of convergence.

While it is perhaps expected that, when considering change in real terms (percentage point change), municipalities with the highest estimates would have seen the most change while municipalities with lower estimates would have seen less change, in considering proportional change, the same pattern held true.

At the national level, model estimates indicate that proportion of adolescents with a first birth at age 19.99 increased from 28.9% in 1990 to a peak of 31.4% in 2005 before falling again to 26.8% in 2020. At age 14.99, the model estimates show an increase from 1.0% in 1990 to a peak of 1.1% in 2001 before falling to 0.9% in 2020.[7]

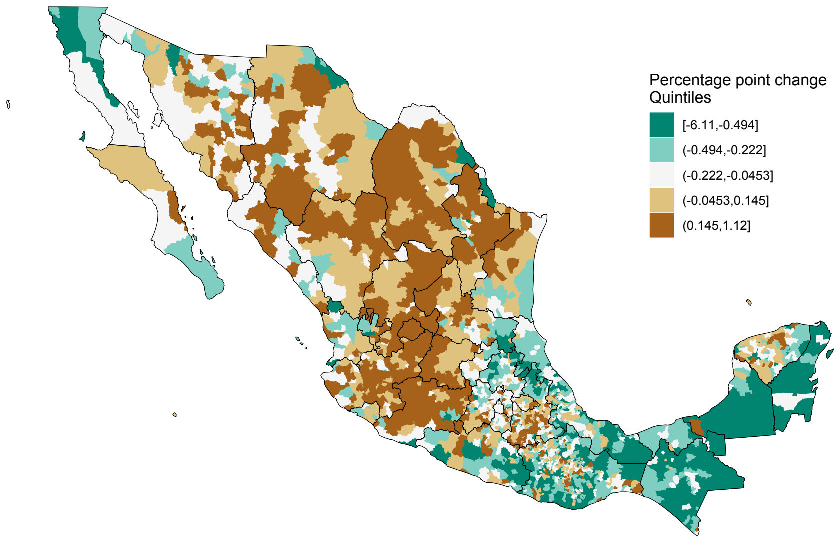
At the municipal level, more substantial change was the norm. That is, just under a fifth of municipalities saw less than 2 percentage point net change in their proportions at age 19.99 from 1990 to 2020. Otherwise, net decline was more common than increase. A full 55% of municipalities saw declines of 2 percentage points or more in their proportion at age 19.99, with up to a 35.1 percentage point decline at age 19.99 and 6.1 percentage point decline at age 14.99. The remaining municipalities (26%) saw from 2 to 23.2 percentage point increases at age 19.99 and up to 1.1 percentage point increase at age 14.99. Furthermore, most municipalities saw nonlinear change, often with complete reversals in their patterns of increase or decline. In essence, comparatively limited change at the national level masked considerable underlying flux within municipalities.

The regression model identified a negative correlation between intercepts and slopes. That is, municipalities with the lowest incidence of births in 1990 tended to see the greatest increase over time. Conversely, municipalities with the highest proportions in 1990 tended to see the strongest decline. Municipalities with more average proportions saw comparatively less change. However, there were many municipalities that contradicted the pattern of convergence. For instance, there were municipalities that started the period of observation with relatively low proportions and subsequently experienced considerable decline. Conversely, there were municipalities that started with higher proportions and experienced some of the greatest increase. Meanwhile, municipalities with minimal change spanned a wide array of starting proportions. In essence, there was a pattern of convergence in municipal first birth trends, though with appreciable exceptions.

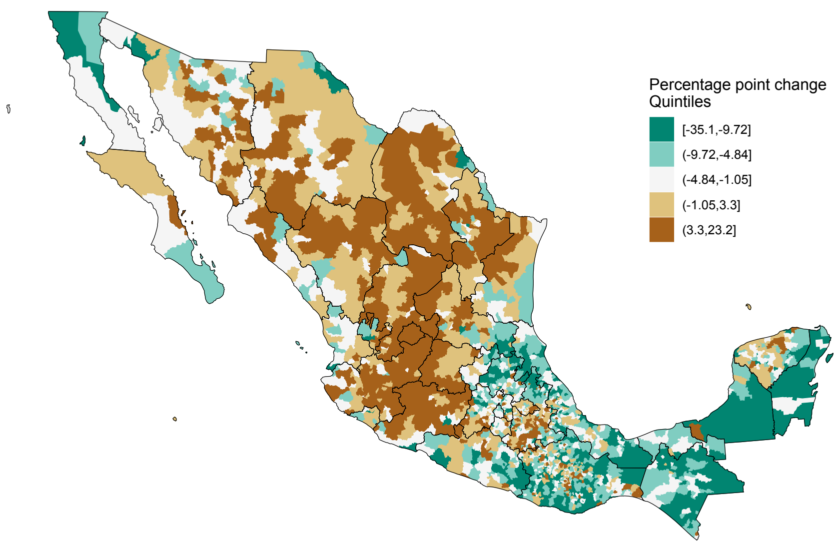
[7] Census proportions for older adolescents (ages 15 to 19) show a bimodal peak with nearly identical proportions in 2000 and 2010, while for younger adolescents the highest proportions are in 1990 with the next highest proportions in 2020 or 2010 alternatively for different ages.

Figure 3: Percentage point change from 1990 to 2020 in the proportion of adolescents in Mexican municipalities with a first birth

(a) at age 14.99



(b) at age 19.99



5.2 Second births in adolescence

Figure 4 depicts the 2020 municipal estimates of the proportion of adolescents aged 19.99 with a second birth and the second birth parity progression ratios, or the proportion of adolescents with a first birth who progressed to a second birth by age 19.99. Recall that parity progression ratios more correctly account for the true risk of a second birth.

For Mexico as a whole, model estimates indicate that in 2020, 5.5% of all 19.99-year-olds had a second birth, which translates to 20.4% of adolescent mothers having progressed to a second birth by age 19.99. That is, one out of every five girls at risk experienced a second birth in adolescence. Second births among adolescents aged 14.99 (not shown) in 2020 were rare but not inexistent. Importantly, progression risk remained high in early adolescence. Model estimates indicate that although only 0.08% of 14.99-year-olds had a second birth in 2020, this translates to 9.5% of adolescent mothers at risk having progressed to a second birth by age 14.99.[8]

Here again, municipal estimates showed considerable diversity, and the figure organizes the range by quintiles. According to the results, municipalities saw that between 9.7% and 48.0% of those at risk of a second adolescent birth had experienced the birth by age 19.99 years – which translates to as few as 0.8% and up to as many as 23.7% of all 19.99-year-olds with a second birth.

Regional clustering indicated high progression ratios were strongly clustered in the south where first birth proportions were also high, whereas some parts of the north that saw the highest first birth proportions did not see the highest ratios of progression to second births. Additionally, many central, interior municipalities saw high progression ratios despite patterns of low first birth proportions.

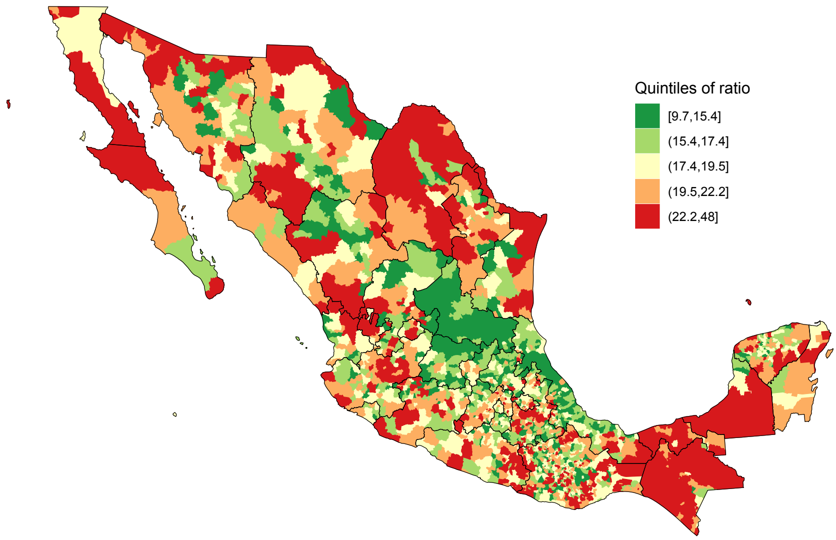
Municipalities with above-average incidence of both first births and progression to second births are obvious candidates for prioritization: 466 municipalities (20%) fall into this category. Nevertheless, other notable patterns include the 305 municipalities (12%) with above-average second birth progression ratios and below-average first birth proportions. Likewise, there are 108 municipalities (4%) with above-average progression ratios but below-average second birth proportions. In both cases, many of these municipalities cluster in the central, interior region. Such municipalities would merit focused interventions for reducing second births but might otherwise go unseen given the lower incidence of first or second birth proportions.

Change over time in the incidence of second births in adolescence is depicted in Figure 5. Here again, change at the national level masks considerable subnational diversity. In the figure, negative values are indicative of a decline over time while positive values reflect an increase over time. Specifically, municipal parity progression ratios declined by between 51.8 and 0.2 percentage points while proportions declined by up to 46.2

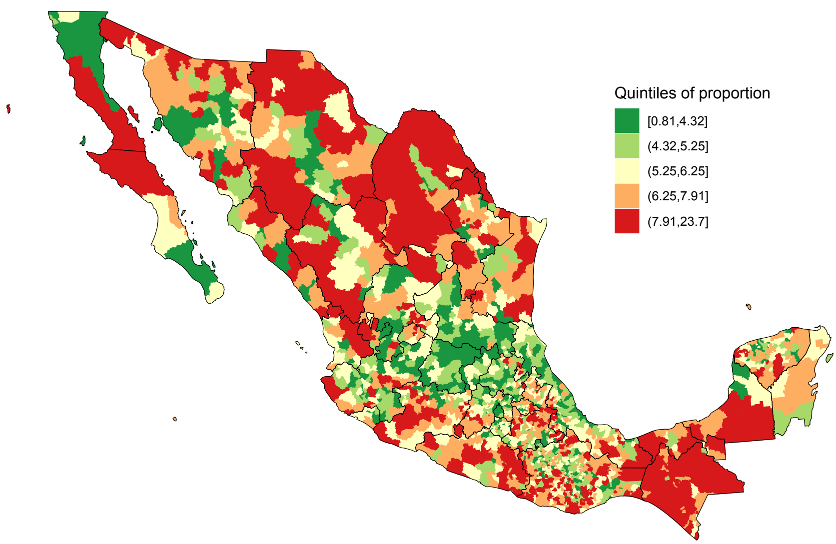
[8] Second birth census proportions were 3.8% for 19-year-olds and 7.4% for 20-year-olds (effectively ages 19.5 and 20.5), and 0.08% for 14-year-olds and 0.1% for 15-year-olds (effectively ages 14.5 and 15.5).

Figure 4: Proportion of adolescents at age 19.99 with a second birth in Mexican municipalities in 2020

(a) adolescent mothers (parity progression ratio)



(b) all adolescents



percentage points or increased by up to 2.3 percentage points. For Mexico as a whole, model estimates indicate that the proportion of 19.99-year-olds with a second birth declined from 11.1% to 5.5% from 1990 to 2020, corresponding to a decline in progression ratios from 38.3% to 20.4% over the same period. In effect, more than two-thirds of municipalities saw greater decline than the national average while the proportion with second births increased in 23 municipalities (due to increases in first births outpacing declines in second births).

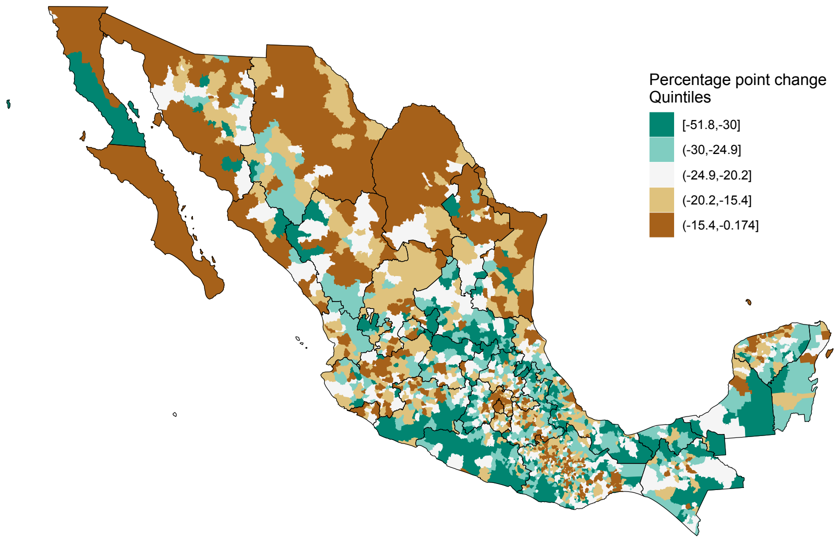
Municipalities with the least decline in progression ratios are concentrated at the far north. Meanwhile, some southern border and southwestern coastal municipalities that had some of the highest ratios in 2020 experienced some of the greatest decline over time.

There is convergence in the second birth progression ratios, but this time, municipalities with the highest ratios in 1990 tended to see the greatest decline over time while municipalities with the lowest ratios tended to see the least decline, though of course with considerable and important exceptions. Critically, the picture becomes much less straightforward when first births are considered. While municipalities with high second birth progression ratios also tend to have high first birth proportions and vice versa, there are many exceptions. For example, many municipalities with a high risk of progression to second births saw low first birth proportions (and considerable diversity in their pace of decline). Meanwhile, there are many municipalities with very strong declines in progression to second births alongside strong increases in first births and conversely, some of the weakest declines in progression to second births alongside some of the strongest declines in first births. Furthermore, many municipalities saw nonlinear change – occasionally with complete reversals in their patterns of increase or decline.

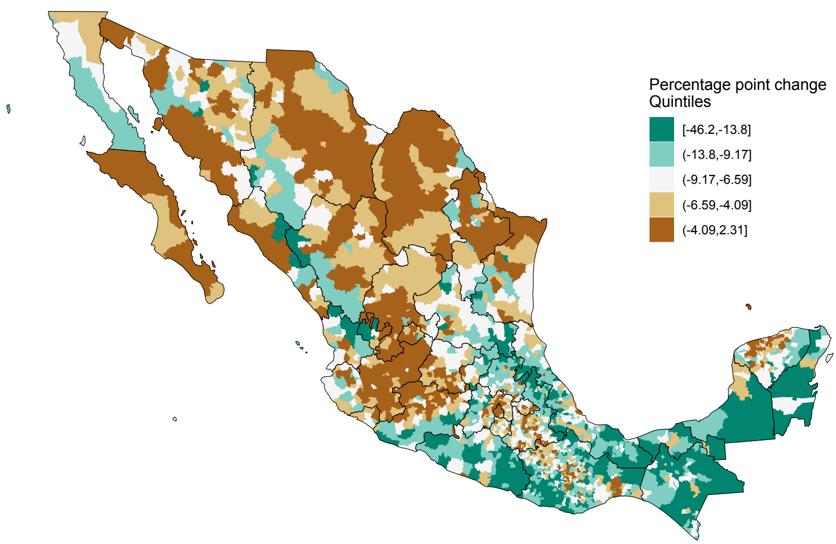
In a final step, it is worth briefly reviewing how these parity-specific patterns relate to official municipal $ASFR_{15\text{-}19}$. Figure 6 plots 2020 $ASFR_{15\text{-}19}$ against this study's estimates. Plot A color codes all municipalities by quintiles of their second birth proportions while Plot B color codes all municipalities by quintiles of their second birth progression ratios. The positive relationship between $ASFR_{15\text{-}19}$ and first birth proportions (seen in both plots) is expected: Municipalities with higher $ASFR_{15\text{-}19}$ tended to have a higher incidence of first births in adolescence. Additionally, the positive relationship between $ASFR_{15\text{-}19}$ and second birth proportions in Plot A is also expected: Municipalities with the highest first and second birth proportions tended to have higher $ASFR_{15\text{-}19}$ than municipalities with the lowest first and second birth proportions. However, the relationship between $ASFR_{15\text{-}19}$ and progression ratios was altogether more chaotic. Indeed, there was comparatively little correspondence between patterns of first birth proportions and second birth progression ratios in Plot B. In fact, most municipalities (57%) do not share the same quintile for second birth progression ratios and second birth proportions.

Figure 5: Percentage point change from 1990 to 2020 in second adolescent births by age 19.99 in Mexican municipalities

(a) adolescent mothers (parity progression ratios)

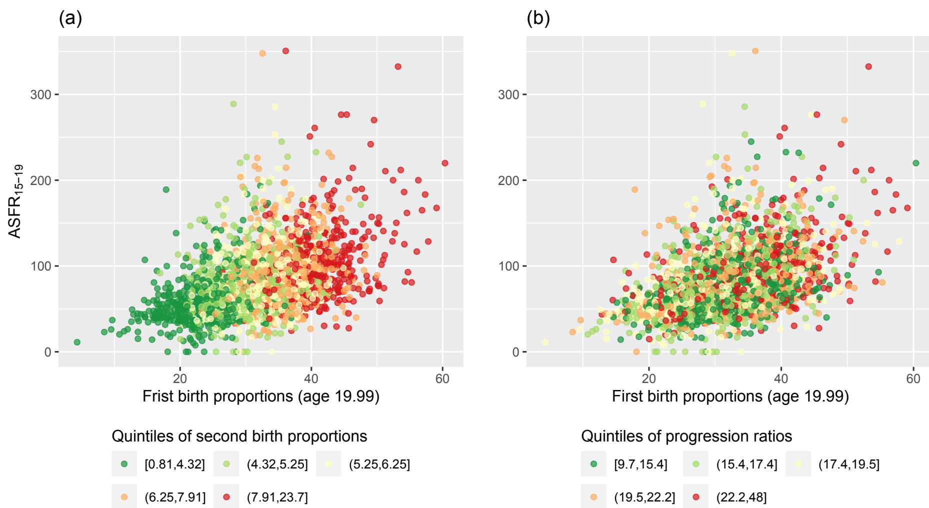


(b) all adolescents



The lack of concordance between first birth proportions and second birth progression ratios is perhaps the most important finding for the second birth estimates. It means that a specific trend for first birth proportions did not guarantee the same trend for patterns of progression to second births. That is, the risk of progressing to a second birth varied considerably across municipalities with similar patterns of first births. Despite widespread declines in second adolescent births across the country, the municipal change in true risk was much more mixed.

Figure 6: Comparison of parity-specific adolescent fertility and adolescent fertility rate, 2020



Finally, model estimates suggest that if current municipal trends were to continue through to 2030, 21.5% of adolescents will have a first birth by age 19.99 (down from 26.8% in 2020), 0.7% will have a first birth by age 14.99 (down from 0.9% in 2020), and second birth progressions by age 19.99 will have declined to 17.9% (down from 20.4%). Simple OLS regressions of the data used in Figure 6 suggest these 2030 proportions correspond to an $ASFR_{15\text{-}19}$ of 57.3. Recall that official forecasts project an $ASFR_{15\text{-}19}$ of 62.2 births in 2030 (CONAPO 2018b). On the one hand, this is positive news, as it implies that greater future declines appear when patterns of subnational flux are taken into account. On the other hand, however, the goal of 32.9 births remains unreachable without a dramatic intensification in the pace of decline. Additionally, the prediction implies that fertility among the youngest adolescents will not have been eliminated and that the pace of decline in second adolescent birth progressions is slowing.

6. Summary and discussion

At the aggregate level, an apparent stagnation in Mexico's $ASFR_{15\text{-}19}$ stands in contrast to the country's healthy pace of development and schooling expansion. This study set out to explore whether the stagnation seen at the national level also defines Mexico's municipal trends. Specifically, it produced estimates of age- and parity-specific adolescent fertility proportions and progression ratios in 2,469 Mexican municipalities over the last 30 years. The estimates reveal a diverse and complex array of trends that have the potential to add sorely needed clarity to an outstanding research and policy puzzle. There has been change in adolescent fertility, only it has occurred at the subnational level and in such a fashion that its overlapping contrasts have manifested as national immobility.

At the national level, about 1 in every 4 girls entered motherhood by age 19.99 while 1 out of every 100 girls entered motherhood by age 14.99 in both 1990 and 2020. Within municipalities, the picture looked rather different: as few as 4.3% and as many as 60.4% of 19.99-year-olds had experienced a first birth in 2020 following declines by up to 35.1 percentage points or increases by up to 23.2 percentage points from 1990 levels. For 14.99-year-olds, between 0.2% and 3.7% had experienced a first birth in 2020 following net declines by up to 6.1 percentage points or increases by up to 1.1 percentage points. For second births in adolescence, the national incidence nearly halved from 1990 to 2020, falling from more than 1 in 10 to 1 in 20 19.99-year-olds with a second birth, and a decline of about 40% to 20% of adolescent mothers progressing to a second birth by age 19.99 over the same period. Here again, the municipal picture is very different. Some municipalities saw a slight increase from 1990 to 2020 in the proportion of adolescents with a second birth (by up to 2.3 percentage points) while most municipalities saw the proportion decline (by up to 46.2 percentage points), with the 2020 incidence ranging between 0.8% and 23.7% of 19.99-year-olds with a second birth. Meanwhile, parity progression ratios among 19.99-year-olds in 2020 ranged between 9.7% and 48%, after having seen net declines from 1990 by between 0.2 and 51.8 percentage points.

In the first instance, simply identifying and mapping fertility trends at smaller geographic areas can make pivotal contributions to efforts to reduce adolescent fertility, as was the case in the United Kingdom. The country's recent adolescent fertility initiative employed detailed subnational adolescent fertility maps to reveal that areas with similar socioeconomic characteristics did not always have similar adolescent fertility, which made the rates seem less inescapable (Hadley, Chandra-Mouli, and Ingham 2016). For Mexico, parity- and age-specific maps debunk the narrative of stagnation and provide opportunity for more targeted intervention.

In effect, stability in $ASFR_{15\text{-}19}$ at the national level has arisen from an increasing incidence of first births in adolescence (until recent declines) alongside a decreasing incidence of second births in adolescence. But this trend is highlighted in existing research and is seen in other countries in the region as well (Neal et al. 2018). This study's findings clarify that at the subnational level, there is a complex picture of convergence where municipalities with the lowest proportions in 1990 have broadly seen the greatest increase over time while municipalities with the highest proportions have seen the greatest decline. Meanwhile, patterns of progression among adolescent mothers at risk of a second birth have seen considerable diversity and do not correspond neatly with levels or changes in first births. Crucially, incongruities in childbearing levels at ages 14.99 and 19.99 within and across municipalities further highlight the underlying complexity.

It is worth reiterating that these high-resolution estimates do not come without uncertainty and should therefore be interpreted with reasonable caution. To recap, previous sections discuss issues arising from data incompleteness (i.e., nonresponses or misstated reports), data collection inadequacies (i.e., the choice of census data compared to vital statistics), and modeling restrictions (i.e., constraining age schedules and change over time to quadratic terms). The online supplementary material delimits further uncertainties inherent in multilevel models and offers estimated standard errors, that, unsurprisingly, indicate that the greatest uncertainty is generally found in the least populated municipalities.

Rather than continuing to revisit the changes, diversity, and geographic patterns of the municipal estimates, the remaining discussion will focus on the broader meaning of these complexities. Though this research did not set out to examine the underlying drivers, it is worth exploring what other literature suggests might be happening in the adolescent fertility landscape in Mexico. This discussion will draw from research evidence that hints of how patterns of social convergence, changes in the proximate determinants of fertility, and insufficient schooling expansion might be motivating the hidden flux.

A social convergence, or at least a shift in the composition of the adolescent population by social strata alongside underlying changes in their fertility determinants, could be at play. Subnational data on the patterns of adolescent sexual activity, contraceptive use, union formation, and pregnancy intention and termination are limited, but where analyzed, variation is considerable, as are differences by rural and urban residence and socioeconomic status (Allen-Leigh et al. 2013; Gómez and González 2018; INEGI 1992, 2018; Juárez et al. 2013). Recent national evidence also finds heterogeneity in age-specific patterns with the most important fertility reductions in recent years happening among the oldest adolescents while younger adolescents have seen little change (Mier y Terán and Llanes 2021). And while self-reported antecedents of adolescent births do not differ by age (e.g., wanting a child or not thinking a pregnancy could happen), births to adolescents 14 years and younger were distinct for seeing much higher contexts of poverty (Pérez Baleón and Lugo 2020).

Parity-specific adolescent fertility in Mexico has long been understood to differ considerably by socioeconomic strata (Stern 2004; Welti Chanes 2006). For disadvantaged adolescents, childbearing is common, and a birth marks the beginning of family formation – meaning that repeat adolescent births are common. In contrast, fertility among more advantaged adolescents often occurs among unpartnered youth for whom the pregnancy was unplanned and repeat adolescent births are rare. Adolescents in Mexico, even those in advantaged strata, are experiencing more and earlier sexual activity than they were in the past without sufficient offsets in contraceptive uptake, thus increasing their risk exposure (Di Cesare 2007; Gómez Muñoz 2018; Gutiérrez et al. 2012; Solís, Gayet, and Juárez 2008; Welti Chanes 2006).

Similarly, research continues to find that women in all but the highest strata are forming unions and marrying at younger ages than in the past (Lima et al. 2018). Additionally, the shifts in union formation and cohabitation that first emerged in the 1990s have been highly differentiated by socioeconomic status, with changes in more disadvantaged strata being more about economic precarity and changes in more advantaged strata being more about shifts in gender and cultural norms (Solís and Ferraris 2014). There continue to exist strong conventions for having children immediately after marriage (Juárez et al. 2013), but adolescents with the highest unmet need for contraception are those in a union rather than those who are sexually active and not in a union (Allen-Leigh et al. 2013).

Across Mexico there remain major barriers to access and uptake of contraception despite widespread knowledge, alongside tenacious cultural and social incentives for early childbearing (Rocca et al. 2010). Various surveys indicate that nearly all adolescents in Mexico report knowledge of at least one method of modern contraception (between 90% to 97% nationally, depending on the survey), but only about half use contraception at their most recent sex (up from a quarter doing so in 2000) (Gutiérrez et al. 2012; INEGI 2009, 2014). Importantly, evidence points to lower contraceptive use rates at first sex and most recent sex among adolescents whose sexual debut occurred in early adolescence compared to later adolescence (Gutiérrez et al. 2012). While some research suggests that many sexually active adolescents intend to become pregnant (Guttmacher Institute 2022), other research cautions that pregnancy intention is highly dependent on question wording and is particularly difficult to measure among adolescents (Sedgh, Singh, and Hussain 2014; Vignoli 2017).

Despite widespread knowledge, a large body of research finds that there remain considerable social barriers to contraceptive use and access among adolescents. It is estimated that nearly half of all adolescents in Mexico who want to avoid pregnancy have an unmet need for contraception, and they have by far the highest unmet need of any age group (Guttmacher Institute 2022). For the youngest adolescents, it appears that embarrassment and concerns of anonymity are significant barriers to access (Gómez-Inclán and Durán-Arenas 2017). For older adolescents, problematic gender norms and lack of planning play a leading role (Azevedo et al. 2012; Lenkiewicz 2013; INEGI 2018).

Importantly, this study has looked at only live births, and evidence suggests trends in adolescent pregnancies and pregnancy terminations could be considerably different (Schiavon, Saavedra, and Darney 2020). Even though access to induced abortion was severely restricted in Mexico over the decades examined, rates of pregnancy termination are sizable and vary considerably subnationally (CONAPO 2018b; Juárez et al. 2013). Access to legal abortion was available from 2007 in Mexico City, but no other decriminalization occurred until after 2019 (Castañeda 2021; Estrada 2022; Juárez, Bankole, and Luis Palma 2019).

All this to say that changing adolescent fertility, as estimated in this study, could well reflect dramatic social shifts in the population – particularly in the proximate determinants of fertility – that have yet to be explored sufficiently subnationally. In some municipalities, changes in cultural proscriptions against adolescent sexual activity outside of marriage, increasing levels of adolescent sexual activity, and sexual activity at younger adolescent ages that have not been matched by sufficient contraceptive uptake could have driven increases. Elsewhere, advances in contraceptive uptake and availability as well as declines in the desirability of early childbearing could have driven declines. It is also possible that mothers from lower socioeconomic strata have seen little change in their progression risk, only that the decline in second births appears universal because of the growing size of Mexico's middle class. Note that this study's models predict a concerning deceleration in the pace of decline in progression risk to second births in coming years.

Mexico's high levels of adolescent fertility in the face of the country's dramatic schooling expansion is also puzzling. Causal evidence from many low- and middle-income contexts confirms that schooling directly reduces adolescent fertility (Baird et al. 2010; Duflo, Dupas, and Kremer 2015; Gulemetova-Swan 2009; Kalamar, Lee-Rife, and Hindin 2016). Additionally, Mexico's extensive and widely lauded cash transfer program Oportunidades, which conditioned benefit payments to poor mothers on the school attendance of their children (among other things), also delayed sexual activity, fertility, and marriage among adolescent girls who were beneficiaries (Gulemetova-Swan 2009; Kalamar, Lee-Rife, and Hindin 2016). However, expansion of the program was highly geographical, appearing first in the center of the country in the late 1990s before expanding into the rural communities on the coasts and in the south in the 2000s before finally including more urban areas and disadvantaged communities in the north after 2014 (Hernandez Olmos 2016; Ordóñez-Barba and Silva-Hernández 2019). Furthermore, some research indicates that although Oportunidades was instrumental in helping Mexico reach universal primary education, it was less effective in inducing change in lower- and upper-secondary schooling, the ages most directly related to adolescent fertility outcomes (Schultz 2004).

Other Mexican studies have argued that high rates of adolescent fertility have persisted because educational changes have occurred at ages that are too young to conflict with the timing of transitions to motherhood and union formation (Kroeger, Frank, and Schmeer 2015; Lindstrom and Paz 2001). Declines in recent years in first birth proportions (and projected future declines) may hint that enough girls in many municipalities are finally reaching the schooling thresholds that matter for reducing first births in adolescence. Currently however, the vast majority of adolescent mothers in Mexico leave school before becoming pregnant (Llanes Díaz 2010), and about half of all 17- to 19-year-olds were not in school in 2020 (INEGI 2021). This echoes research in Europe that clarifies that though the age at first birth has dramatically increased, the timing of first births have changed relatively little when measured in terms of years since leaving education (Neels et al. 2017; Ní Bhrolcháin and Beaujouan 2012).

Issues of education quality also come to the fore with such rapid expansion of school enrollment, as well as with findings that disenchantment with school and its poor quality lead many adolescents out of school (Näslund-Hadley and Binstock 2011). Mexico performs poorly in international learning assessments and has seen little improvement over the last decades (OECD 2011; Salinas, De Morales, and Schwabe 2019). Importantly, learning achievement differs dramatically by school type: Students in private secondary schools see markedly better learning outcomes than students in conventional public secondary schools who in turn see considerably better learning outcomes than students in public *telesecundarias*, a type of secondary schooling found in rural settings that relies heavily on distance learning modules (Saraví 2009).

Furthermore, aspects of increasing rates of gang and gender-based violence as well as low levels of youth employment – which manifest strong geographic clustering – mar the picture of stability and progress (Berlanga Gayón 2015; Llanes Díaz 2010; Pan American Health Organization 2012; Rosen and Zepeda 2016). Marked increases in homicide rates in Mexico in recent years are enough to have stunted life expectancy gains, and there is some evidence that higher mortality among close kin is associated with earlier childbearing (Berg, Lawson, and Rotkirch 2020; Brown and Sear 2021; Canudas-Romo and Aburto 2019), but this possibility has not been explored in Mexico. Additionally, low expectations and limited prospects for labor force participation are often closely tied to early childbearing (Azevedo et al. 2012; Ibarraran et al. 2014; Novella and Ripani 2016).

A small handful of subnational research from other countries in the region echoes the mixed messages from Mexico. Even when national rates of teen childbearing are falling, subnational decline and adolescent fertility's association to poverty and socioeconomic status is far from uniform within a country. In Colombia, adolescent fertility among older teens is increasing in the coastal regions but declining elsewhere, and fertility among younger teens is increasing everywhere (Alvarez Castaño 2015). In two Colombian cities with similar levels of adolescent fertility, rates differ strongly among the lowest socioeconomic strata but are similar among the higher strata (Flórez 2005). In Chile, by contrast, rates of adolescent fertility in urban areas are closely tied to poverty, but in rural areas teen childbearing is high no matter the poverty rates (Velarde and Zegers-Hochschild 2017). Across several countries, it appears that education matters most in the areas with highest adolescent fertility. That is, in the subnational regions where teen childbearing is high, individual schooling is strongly related to the probability of adolescent fertility, but the relationship is less pronounced in areas with lower adolescent fertility (Núñez and Flórez 2001). While rural and poor women generally continue to have the highest incidence of adolescent fertility throughout the region, rates of change see increases in urban settings and declines in rural contexts in some places and the opposite in others (Berquó and Cavenaghi 2005; Di Cesare 2007; Gómez and González 2018; Neal et al. 2018).

Importantly, it is likely that these aforementioned shifts intersect with adolescents' sexual and reproductive trajectories differently at different ages. Recall that in nearly half of municipalities, the estimates at ages 14.99 and 19.99 did not share the same quintile, suggesting that the childbearing patterns in later adolescence are not predetermined by patterns in early adolescence and vice versa. This suggests that the changes in individual and contextual circumstances underlying Mexico's adolescent childbearing landscape are not uniform across the adolescent age schedule. That is, what the youngest adolescents need to reduce their fertility risk differs from what is needed for older adolescents.

Notwithstanding the remaining questions of how the shifting social and educational context interplay with Mexico's changing subnational adolescent fertility, there is much to be gained from this study. Municipal age- and parity-specific adolescent fertility estimates offer needed direction to Mexico's national strategy to reduce adolescent childbearing, as they could in other countries. $ASFR_{15\text{-}19}$ measures cannot offer the same level of detail. This study has revealed a picture of adolescence in flux, or a diverse array of municipal trends in first and second adolescent births across the country. It has also highlighted a fair number of priority municipalities that would likely be overlooked in the country's current strategy to reduce adolescent childbearing. In conclusion, the benefits of paying attention to subnational and parity-specific adolescent fertility trends – at different adolescent ages – cannot be overstated.

References

Ailines Genis, L. (2018). Niveles y tendencias de la tasa de fecundidad adolescente en México. Estimaciones por entidad federativa y municipio, 2010 y 2015. Congreso Internacional de Asociación Latinoamericana de Población, Puebla, México.

Allen-Leigh, B., Villalobos-Hernández, A., Hernández-Serrato, M.I., Suárez, L., Vara, E.D.L., de Castro, F., and Schiavon-Ermani, R. (2013). Inicio de vida sexual, uso de anticonceptivos y planificación familiar en mujeres adolescentes y adultas en México. *Salud Pública de México* 55(suppl2): S235–S240. doi:10.21149/spm.v55s2.5120.

Alvarez Castaño, V.H. (2015). Distribución territorial y determinantes de la fecundidad adolescente en Colombia. *Notas de Población, Naciones Unidas Comisión Económica para América Latina y el Caribe (CEPAL)* 101: 79–108. doi:10.18356/c1b41c50-es.

Azevedo, J.P., Favara, M., Haddock, S.E., Lopez-Calva, L.F., Müller, M., and Perova, E. (2012). Teenage pregnancy and opportunities in Latin America and the Caribbean: On teenage fertility decisions, poverty and economic achievement. Washington DC: World Bank Group.

Bailey, P., Kelley, C., Ngyuen, T., Huo, H., and Kjeldsen, C. (2020). Weighted mixed-effects models using multilevel pseudo maximum likelihood estimation. https://cran.r-project.org/web/packages/WeMix/WeMix.pdf.

Baird, S., Chirwa, E., McIntosh, C., and Özler, B. (2010). The short-term impacts of a schooling conditional cash transfer program on the sexual behavior of young women. *Health Economics* 19(S1): 55–68. doi:10.1002/hec.1569.

Bates, D., Mächler, M., Bolker, B., and Walker, S. (2015). Fitting linear mixed-effects models using Lme4. *Journal of Statistical Software* 67(1): 1–48. doi:10.18637/jss.v067.i01.

Berg, V., Lawson, D., and Rotkirch, A. (2020). Financial opportunity costs and deaths among close kin are independently associated with reproductive timing in a contemporary high-income society. *Proceedings of the Royal Society B* 287(1919): 20192478. doi:10.1098/rspb.2019.2478.

Berlanga Gayón, M. (2015). El espectáculo de la violencia en el México actual: del feminicidio al juvenicidio. *Athenea digital* 15(4): 105–128. doi:10.5565/rev/athenea.1556.

Berquó, E. and Cavenaghi, S. (2005). *Increasing adolescent and youth fertility in Brazil: A new trend or a one-time event?* Paper presented at the Annual Meeting of the Population Association of America. Philadelphia, Pennsylvania.

Binder, M. and Woodruff, C. (2002). Inequality and intergenerational mobility in schooling: the case of Mexico. *Economic Development and Cultural Change* 50(2): 249–267. doi:10.1016/j.chieco.2023.101943.

Brown, L.J. and Sear, R. (2021). How do reproduction, parenting, and health cluster together? Exploring diverging destinies, life histories and weathering in two UK cohort studies. *Advances in Life Course Research* 50: 100431. doi:10.1016/j.alcr.2021.100431.

Canudas-Romo, V. and Aburto, J.M. (2019). Youth lost to homicides: Disparities in survival in Latin America and the Caribbean. *BMJ Global Health* 4: e001275. doi:10.1136/bmjgh-2018-001275.

Carle, A.C. (2009). Fitting multilevel models in complex survey data with design weights: Recommendations. *BMC Medical Research Methodology* 9(49). doi:10.1186/1471-2288-9-49.

Castañeda, M.J. (2021). Mapa de la despenalización del aborto en México: En 28 de 32 estados sigue siendo delito. El País. https://elpais.com/mexico/2021-09-12/mapa-de-la-despenalizacion-del-aborto-en-mexico-en-28-de-32-estados-sigue-siendo-delito.html.

CONAPO (2015). Consejo Nacional de Población. Estrategia nacional para la prevención del embarazo en adolescentes. https://www.gob.mx/conapo/documentos/documento-oficial-de-la-estrategia.

CONAPO (2018a). Consejo Nacional de Población. Indicadores diversos 1990 - 2015: Indicadores diversos a partir de INEGI/SALUD, ONUSIDA, SALUD y SEP, donde se utilizan como denominadores a las proyecciones de población. Gobierno de México Datos Abiertos. https://datos.gob.mx/busca/dataset/proyecciones-de-la-poblacion-de-mexico-y-de-las-entidades-federativas-2016-2050/resource/dbc40fe2-3adb-405e-b85f-00b11208020e.

CONAPO (2018b). Consejo Nacional de Población. Proyecciones de la población de México y de las entidades federativas, 2016-2050 - tasa específica de fecundidad y nacimientos, 1950-2050. https://datos.gob.mx/busca/dataset/proyecciones-de-la-poblacion-de-mexico-y-de-las-entidades-federativas-2016-2050/resource/bb8f26dc-c54f-47e6-b53b-1474fb40292c.

CONAPO (2020). Consejo Nacional de Población. Salud sexual y reproductiva: Principales indicadores y tasa de fecundidad de las mujeres de 15 a 19 por municipio, 2010 y 2015. Gobierno de México Datos Abiertos. https://www.datos.gob.mx/busca/dataset/salud-sexual-y-reproductiva.

CONAPO (2021). Consejo Nacional de Población. Tasa de fecundidad adolescente nacional, por entidad federativa y municipio, 2020. Gobierno de México Datos Abiertos.

https://datos.gob.mx/busca/dataset/salud-sexual-y-reproductiva/resource/e2ec3268-3344-42d2-a747-a20e65bc09f9.

CONAPO (2022). Consejo Nacional de Población. Salud sexual y reproductiva: Principales indicadores y tasa de fecundidad de las mujeres de 15 a 19 por municipio, 2010 y 2015. https://www.datos.gob.mx/busca/dataset/salud-sexual-y-reproductiva.

CONEVAL (2020). Consejo Nacional de Evaluación de la Política de Desarrollo Social. Evolución de las dimensiones de la pobreza 1990-2018.

CONEVAL (2022). Consejo Nacional de Evaluación de la Política de Desarrollo Social. Medición multidimensional de la pobreza en México, 2016 - 2020.

Di Cesare, M. (2007). América Latina: Patrones emergentes en la fecundidad y la salud sexual y reproductiva y sus vínculos con la reducción de la pobreza. *Notas de Población* 84: 11–51.

Diario Oficial (1917). Original: Constitución Política de Los Estados Unidos Mexicanos. Artículo 3.

Diario Oficial (1993). Decreto que declara reformados los artículos 3o. y 31 fracción I, de la Constitución Política de los Estados Unidos Mexicanos.

Diario Oficial (2012). Decreto por el que se declara reformado el párrafo primero; el inciso c) de la fracción II y la fracción V del artículo 3o., y la fracción I del artículo 31 de la Constitución Política de los Estados Unidos Mexicanos.

Duflo, E., Dupas, P., and Kremer, M. (2015). Education, HIV, and early fertility: Experimental evidence from Kenya. *American Economic Review* 105(9): 2757–2797. doi:10.1257/aer.20121607.

Estrada, A. (2022). Aborto en México: ¿Dónde es legal? Animal MX. https://animal.mx/salud-y-estilo-de-vida/donde-es-legal-el-aborto-en-mexico/.

Flórez, C.E. (2005). Factores socioeconómicos y contextuales que determinan la actividad reproductiva de las adolescentes en Colombia. *Revista Panamericana de Salud Pública* 18(6): 388–402. doi:10.1590/S120-49892005001000002.

Garbett, A. (2022). Adolescent childbearing and schooling in Latin America and the Caribbean: Using population data to demystify a demographic puzzle of continuity and change. (PhD thesis). University of Southampton: Social Statistics and Demography.

Garbett, A., Perelli-Harris, B., and Neal, S. (2021). The untold story of 50 years of adolescent fertility in West Africa: A cohort perspective on the quantum, timing, and spacing of adolescent childbearing. *Population and Development Review* 47(1): 7–40. doi:10.1111/padr.12384.

Goldstein, H. (1997). Methods in school effectiveness research. *School Effectiveness and School Improvement* 8(4): 369–395. doi:10.1080/0924345970080401.

Gulemetova-Swan, M. (2009). Evaluating the impact of conditional cash transfer programs on adolescent decisions about marriage and fertility: The case of Oportunidades. (PhD thesis) University of Pennsylvania.

Gutiérrez, J.P., Vieitez, I., López, Z., Ríos, P., Llanes, N., Atonal, B., and Villegas, M. (2015). Diseño del plan de monitoreo y del esquema general de evaluación de La Estrategia Nacional Para La Prevención Del Embarazo En Adolescentes. Instituto Nacional de Salud Pública. Documento 2. Plan de monitoreo.

Gutiérrez, J.P., Rivera-Dommarco, J., Shamah-Levy, T., Villalpando-Hernández, S., Franco, A., Cuevas-Nasu, L., Romero-Martínez, M., and Hernández-Ávila, M. (2012). Encuesta Nacional de Salud y Nutrición 2012. Resultados nacionales. Cuernavaca, México. Instituto Nacional de Salud Pública (MX).

Guttmacher Institute (2022). Data center: Mexico. https://data.guttmacher.org/countries/table?country=MX.

Gómez, O.S.M. and González, K.O. (2018). Fecundidad en adolescentes y desigualdades sociales en México, 2015. *Revista Panamericana de Salud Pública* 42. doi:https://doi.rog/10.26633/RPSP.2018.99. doi:10.26633/RPSP.2018.99.

Gómez-Inclán, S. and Durán-Arenas, L. (2017). El acceso a métodos anticonceptivos en adolescentes de la Ciudad de México. *Salud pública México* 59(3). doi:10.21149/7891.

Gómez Muñoz, M. (2018). Embarazo adolescente en México: Riesgos, retos y expectativas. In: García Estrada, I. (ed.). *Juventudes. Género y salud sexual y reproductiva: Realidades, expectativas y retos*. Gedisa: 189–213.

Hadley, A., Chandra-Mouli, V., and Ingham, R. (2016). Implementing the United Kingdom government's 10-year teenage pregnancy strategy for England (1999–2010): Applicable lessons for other countries. *Journal of Adolescent Health* 59(1): 68–74. doi:10.1016/j.jadohealth.2016.03.023.

Hernández, M.F., Muradás, M.d.l.C., and Sánchez, M. (2015). Panorama de la salud sexual y reproductiva, 2014. Consejo Nacional de Población.

Hernandez Olmos, P. (2016). PROSPERA programa de inclusión social: Experiencia mexicana en la implementación de los programas de transferencias condicionadas. Mexico - Secretaria De Desarrollo Social, SEDESOL. https://socialprotection.org/es/discover/multimedia/experiencia-mexicana-en-la-implementación-de-los-programas-de-transferencias.

Hindin, M.J., Kalamar, A.M., Thompson, T., and Upadhyay, U. (2016). Interventions to prevent unintended and repeat pregnancy among young people in low- and middle-income countries: A systematic review of the published and gray literature. *Journal of Adolescent Health* 59(3 Supplement): S8–S15. doi:10.1016/j.jadohealth.2016.04.021.

Ibarraran, P., Ripani, L., Taboada, B., Villa, J.M., and Garcia, B. (2014). Life skills, employability and training for disadvantaged youth: Evidence from a randomized evaluation design. *IZA Journal of Labor & Development* 3(1): 10. doi:10.1186/2193-9020-3-10.

INEGI (1990). Sistema Nacional de Información Estadística y Geográfica. Principales resultados por localidad (ITER). https://www.inegi.org.mx/programas/ccpv/1990/#Microdatos.

INEGI (1992). Encuesta Nacional de la Dinámica Demográfica: Principales resultados. https://www.inegi.org.mx/contenidos/productos/prod_serv/contenidos/espanol/bvinegi/productos/historicos/1290/702825415716/702825415716_1.pdf.

INEGI (2000). Sistema Nacional de Información Estadística y Geográfica. Principales resultados por localidad (ITER). https://www.inegi.org.mx/programas/ccpv/2000/#Microdatos.

INEGI (2005). Sistema Nacional de Información Estadística y Geográfica. Principales resultados por localidad (ITER). https://www.inegi.org.mx/programas/ccpv/2005/#Microdatos.

INEGI (2009). Encuesta Nacional de la Dinámica Demográfica: Tabulados anticoncepción. https://www.inegi.org.mx/programas/enadid/2009/#Tabulados.

INEGI (2010). Sistema Nacional de Información Estadística y Geográfica. Principales resultados por localidad (ITER). https://www.inegi.org.mx/programas/ccpv/2010/#Microdatos.

INEGI (2014). Encuesta Nacional de la Dinámica Demográfica: Tabulados anticoncepción. https://www.inegi.org.mx/programas/enadid/2014/#Tabulados.

INEGI (2015). Instituto Nacional de Estadística y Geografía. Encuesta Intercensal 2015. https://www.inegi.org.mx/programas/intercensal/2015/.

INEGI (2018). Instituto Nacional de Estadística y Geografía. encuesta Nacional de la Dinámica Demográfica: Tabulados. https://www.inegi.org.mx/programas/enadid/2018/#Tabulados.

INEGI (2020a). Sistema Nacional de Información Estadística y Geográfica. Censo de pablación y vivienda 2020: Síntesis metodológica y conceptual. https://inegi.org.mx/contenidos/productos/prod_serv/contenidos/espanol/bvinegi/

productos/nueva_estruc/702825197537.pdf.

INEGI (2020b). Sistema Nacional de Información Estadística y Geográfica. Principales resultados por localidad (ITER). https://www.inegi.org.mx/programas/ccpv/2020/#Microdatos.

INEGI (2021). Instituto Nacional de Estadística y Geografía. Censo de población y vivienda 2020. Tabulados del cuestionario básico. Población de 3 años y más por entidad federativa, sexo y edad según condición de asistencia escolar. https://www.inegi.org.mx/programas/ccpv/2020/#Tabulados.

INEGI (2022a). Instituto Nacional de Estadística y Geografía. Censo de población y vivienda 1990, 2000, 2005 (Conteo), 2010, 2020. https://www.inegi.org.mx/programas/ccpv/2010/.

INEGI (2022b). Sistema Nacional de Información Estadística y Geográfica. Catálogo nacional de indicadores: Tasa neta de cobertura en primaria, secundaria y educación media superior. https://www.snieg.mx/cni/indicadores.aspx?idOrden=1.4.

Juárez, F., Bankole, A., and Luis Palma, J. (2019). Women's abortion seeking behavior under restrictive abortion laws in Mexico. *PLoS One* 14(12): e0226522. doi:10.1371/journal.pone0226522.

Juárez, F., Singh, S., Maddow-Zimet, I., and Wulf, D. (2013). Unintended pregnancy and induced abortion in Mexico: Causes and consequences. Guttmacher Institute: New York. https://www.guttmacher.org/report/unintended-pregnancy-and-induced-abortion-mexico-causes-and-consequences.

Kalamar, A.M., Lee-Rife, S., and Hindin, M.J. (2016). Interventions to prevent child marriage among young people in low- and middle-income countries: A systematic review of the published and gray literature. *Journal of Adolescent Health* 59(3, Supplement): S16–S21. doi:10.1016/j.jadohealth.2016.06.015.

Knowles, J. and Frederick, C. (2020a). merTools. Tools for analyzing mixed effect regression models. R package version 0.5.2 https://CRAN.R-project.org/package=merTools.

Knowles, J. and Frederick, C. (2020b). Prediction intervals from merMod objects. https://cran.r-project.org/web/packages/merTools/vignettes/Using_predictInterval.html.

Kroeger, R.A., Frank, R., and Schmeer, K.K. (2015). Educational attainment and timing to first union across three generations of Mexican women. *Population research and policy review* 34(3): 417–435. doi:10.1007/s11113-014-9351-8.

Lenkiewicz, N.E. (2013). The voices of pregnant adolescents: The gap between reproductive health policies and women's realities. *Romanian Sociology / Sociologie*

Româneascâ 11(3): 22–42.

Lima, E.E.C., Zeman, K., Sobotka, T., Nathan, M., and Castro, R. (2018). The emergence of bimodal fertility profiles in Latin America. *Population and Development Review* 44(4): 723–743. doi:10.1111/padr.12157.

Lindstrom, D.P. and Paz, C.B. (2001). Alternative theories of the relationship of schooling and work to family formation: Evidence from Mexico. *Social Biology* 48(3-4): 278–297. doi:10.1080/19485565.2001.9989039.

Llanes Díaz, N. (2010). La maternidad adolescente y su efecto sobre la salida de la escuela entre mujeres mexicanas: Replanteamientos y consideraciones. *FLASCO México* https://ssrn.com/abstract=630776.

Meneses, E. and Hernández, M.F. (2019). Estimaciones de la tasa de fecundidad en adolescentes a nivel municipal en México. Magnitudes y tendencias entre 2010 y 2015. Secretaría General del Consejo Nacional de la Población. https://www.gob.mx/conapo/documentos/la-situacion-demografica-de-mexico-2018.

Meneses, E. and Ramírez, M. (2018). Niveles y tendencias de la fecundidad en niñas y adolescentes de 10 a 14 años en México y características de las menores y de los padres de sus hijos e hijas, a partir de las estadísticas vitales de nacimientos de 1990 a 2016. *Notas de Población* 106: 117–152. doi:10.18356/cff735fd-es.

Mier y Terán, M. and Llanes, N. (2021). El descenso reciente de la fecundidad adolescente y la escolaridad en México, 2010-2020. *Conyuntura Demográfica* 20: 35–43.

Mier y Terán, M. and Rabell Romero, C. (2003). Inequalities in Mexican children's schooling. *Journal of Comparative Family Studies* 34(3): 435–454. doi:10.3138/jcfs.34.3.435.

Moreno-Brid, J.C. and Ros, J. (2009). *Development and Growth in the Mexican Economy: A Historical Perspective*. Oxford University Press. doi:10.1093/acprof:oso/9780195371161.001.1.

Neal, S., Harvey, C., Chandra-Mouli, V., Caffe, S., and Camacho, A.V. (2018). Trends in adolescent first births in five countries in Latin America and the Caribbean: Disaggregated data from Demographic and Health Surveys. *Reproductive Health* 15(1): 146. doi:10.1186/s12978-018-0578-4.

Neels, K., Murphy, M., Ní Bhrolcháin, M., and Beaujouan, E. (2017). Rising educational participation and the trend to later childbearing. *Population and Development Review* 43(4): 667–693. doi:10.1111/padr.12112.

Novella, R. and Ripani, L. (2016). Are you (not) expecting? The unforeseen benefits of job training on teenage pregnancy. *IZA Journal of Labor & Development* 5(1): 19.

doi:10.1186/s40175-016-0065-7.

Näslund-Hadley, E. and Binstock, G. (2011). El fracaso educativo: Embarazos para no ir a la clase. Banco Interamericano de Desarrollo.

Ní Bhrolcháin, M. and Beaujouan, E. (2012). Fertility postponement is largely due to rising educational enrolment. *Population Studies* 66(3): 311–327. doi:10.1080/00324728.2012.697569.

Núñez, J. and Flórez, C.E. (2001). Teenage childbearing in Latin American countries. *IDB Working Paper No. 147* doi:10.2139/ssrn.1814694.

OECD (2011). Lessons from PISA for Mexico, Strong performers and successful reformers in education. *OECD Publishing* doi:10.1787/9789264107243.

Ordóñez-Barba, G.M. and Silva-Hernández, A.L. (2019). Progresa-oportunidades-prospera: Avatares, alcances y resultados de un programa paradigmático contra la pobreza. *Papeles de Población* 25(99): 1405–7425.

Pan American Health Organization (2012). Violence against women in Latin America and the Caribbean: A comparative analysis of population-based data from 12 countries. (Technical report). Pan American Health Organization. https://iris.paho.org/handle/106665.2/3471.

Pérez Baleón, G. and Lugo, M. (2020). Contextos sociales, reproductivos y de pareja que delimitan los embarazos en mujeres menores de 15 años: Un análisis comparativo entre etapas de la adolescencia. In: Pérez Baleón, G. and Lugo, M. (eds.). *Los claroscuros del embarazo en la adolescencia: Un enfoque cuantitativo*. México: Orfila and Universidad Nacional Autónoma de México (UNAM): 75–100.

Pérez-Campuzano, E. and Santos-Cerquera, C. (2013). Tendencias recientes de la migración interna en México. *Papeles de Población* 19(76): 53–88.

Remmer, K (1991). The political impact of economic crisis in Latin America in the 1980s. *American Political Science Review* 85(3): 777–800. doi:10.2307/1963850.

Rocca, C.H., Doherty, I., Padian, N.S., Hubbard, A.E., and Minnis, A.M. (2010). Pregnancy intentions and teenage pregnancy among Latinas: A mediation analysis. *Perspectives on Sexual and Reproductive Health* 42(3): 186–196. doi:10.1363/4218610.

Rosen, J.D. and Zepeda, R. (2016). Una década de narcoviolencia en México: 2006-2016. *Atlas de la seguridad y la defensa de México* 59: 55–65.

Salinas, D., De Morales, C., and Schwabe, M. (2019). Mexico – Country Note – programme for international student assessment (PISA) results from PISA 2018. *OECD Publishing* I-II.

Saraví, G. (2009). *Transiciones vulnerables: Juventud, desigualdad y exclusión en México*. México: Centro de Investigaciones y Estudios Superiores en Antropología Social (CIESAS). doi:10.18356/b100ef11-es.

Schiavon, R., Saavedra, B., and Darney, B. (2020). Fecundidad en mujeres jóvenes: Nueva evidencia sobre el papel del aborto. In: Pérez Baleón, G. and Lugo, M. (eds.). *Los claroscuros del embarazo en la adolescencia: un enfoque cuantitativo*. México: Orfila and Universidad Nacional Autónoma de México (UNAM): 225–244.

Schultz, P. (2004). School subsidies for the poor: Evaluating the Mexican Progresa poverty programme. *Journal of Development Economics* 74(1): 199–250. doi:10.1016/j.jdeveco.2003.12.009.

Sedgh, G., Singh, S., and Hussain, R. (2014). Intended and unintended pregnancies worldwide in 2012 and recent trends. *Studies in Family Planning* 45(3): 301–314. doi:10.1111/j.1728-4465.2014.00393.x.

Si, Y., Pillai, N.S., and Gelman, A. (2015). Bayesian nonparametric weighted sampling inference. *Bayesian Analysis* 10(3): 605–625. https://doi.org/10.1213/14-BA924.

Solís, P. and Ferraris, S. (2014). Nuevo siglo, ¿nuevas pautas de formación y disolución de uniones? In: Rabell, C. (ed.). *Los mexicanos. Un balance del cambio demográfico*. México: Fondo de Cultura Económica: 269–305.

Solís, P., Gayet, C., and Juárez, F. (2008). Las transiciones a la vida sexual, a la unión y a la maternidad en México: Cambios en el tiempo y estratificación social. In: Lerner, S. and Szasz, I. (eds.). *Salud reproductiva y condiciones de vida en México*. México: El Colegio de México: 397–428.

Stern, C. (2004). Vulnerabilidad social y embarazo adolescente en México. *Papeles de Población* 10(39): 129–158.

UN DESA (2022). United Nations, Department of Economic and Social Affairs, Population Division. World Population Prospects 2022: file gen/01/fev1: Demographic indicators by region, subregion and country, annually for 1950-2100. Online Edition.

UN General Assembly (2017). Resolution no. 71/313. work of the statistical commission pertaining to the 2030 agenda for sustainable development. UN General Assembly Resolution. Resolution No. 71/313 https://documents-dds-ny.un.org/doc/UNDOC/GEN/N17/207/63/PDF/N1720763.pdf?OpenElement.

UN Population Division (2019). Adolescent fertility rate (births per 1,000 women ages 15-19) – Sub-Saharan Africa, Latin America & Caribbean, Middle East & North Africa, South Asia, Europe & Central Asia, East Asia & Pacific (excluding high income), North America. World Bank. https://data.worldbank.org/indicator/SP.ADO.TFRT?locations=ZG-ZJ-ZQ-8S-Z7-

4E-XU.

UN Population Division (2020). World Fertility Data 2019. Custom data acquired from the website. https://www.un.org/development/desa/pd/data/world-fertility-data.

UN Statistics Division (2021). Demographic Statistics Database, custom data acquired via website.

UNFPA (2022). Motherhood in childhood: the untold story. https://www.unfpa.org/publications/motherhood-childhood-untold-story.

Velarde, M. and Zegers-Hochschild, F. (2017). Measuring the distribution of adolescent births among 15–19-year olds in Chile: An ecological study. *Journal of Family Planning and Reproductive Health Care* 43: 302–308. doi:10.1136/jfprhc-2015-101230.

Vignoli, J.R. (2017). Deseabilidad y planificación de la fecundidad adolescente en América Latina y el Caribe: Tendencias y patrones emergentes. *Notas de Población* 44(104): 119–144. https://doi.org/10.18356/d8191782-es.

Ward, V.M., Santiso-Gálvez, R., and Bertrand, J.T. (2015). Family Planning in Mexico: The Achievements of 50 Years. Measure Evaluation. SR-15-118E.

Welti Chanes, C. (2006). Las encuestas nacionales de fecundidad en México y la aparición de la fecundidad adolescente como tema de investigación. *Papeles de Población* 12(50): 253–275.

World Bank (2021). World Development Indicators. Gross domestic product ranking table. Custom data acquired from website. https://datacatalog.worldbank.org/dataset/gdp-ranking.