

# **Adolescent Fertility Rates in Guatemala: The Socioeconomic and Agricultural Context**

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## **Abstract**

Adolescent fertility is shaped by a complex interplay between individual choices and the broader socioeconomic context; this is especially visible in countries where agricultural production remains a key part of the society. This study examines the influence of different agricultural production systems and sociocultural and demographic factors in adolescent fertility patterns in Guatemala. Using nationally representative census and high-resolution land-use and land-cover data, the analysis explores both individual-level probabilities of early motherhood and municipal-level fertility rates. This integrated approach highlights the contextual and environmental influences embedded within diverse local settings.

The findings reveal that adolescent fertility is shaped by intertwined sociocultural systems encompassing agricultural production typologies, sociodemographic characteristics, and household structures. Monoculture agro-export areas, marked by demanding labour conditions and complex social dynamics, differ from subsistence and semi-commercial systems, though all reflect variations of traditional family networks and social norms influencing reproductive behaviour. Life aspirations, particularly education and marital status, are central factors linked to fertility outcomes, while digital connectivity and migration highlight broader social transformations impacting adolescent reproductive decisions. These insights highlight the necessity of integrating economic production contexts with sociocultural and demographic dimensions to fully understand fertility patterns in settings of uneven modernization.

## **Key Words**

Adolescent fertility, agricultural production systems, sociocultural context, fertility determinants.

## 1. Background and Research Aim

Adolescent fertility represents a critical life course phase for examining how reproductive behaviour is influenced by the interaction between individual personal choice and the broader structural context. Multiple factors can influence early childbearing, while reproductive behaviour can be an individual choice, these decisions occur within layered social systems ranging from family, peer networks, community and institutions that can shape fertility timing and intentions (Garbett et al. 2025; Gausman et al. 2019; Kahn & Anderson 1992; Shakya et al. 2019; Barber 2000). Exploring early childbearing consequently reveals not only personal trajectories but also the structural determinants of fertility behaviour, particularly in settings where modernization processes remain uneven.

Family, kingship dynamics and institutional exposure during formative years are key proximate contextual factors influencing adolescents' reproductive behaviour. Mechanisms such as expectations around family formation and fertility preferences influence early childbearing within these settings (Balbo & Barban, 2014; Esteve et al. 2022; Shakya et al. 2019; Shaver et al. 2020). For example, extended family systems, common in agrarian and low-income settings, function not only as domestic units for cultural transmission but also promote marriage and fertility expectations. These arrangements often enable cooperation and household security, shaping life aspirations and family formation intentions among adolescents (Caldwell 2005; Sear 2017; Stulp et al. 2016).

Broader sociocultural systems structure the conditions under which reproductive behaviours are shaped and sustained. The demographic transition theory provides a framework to exemplify the intertwined relationship between the context and fertility outcomes, where transformations in socioeconomic systems being associated with fertility decline (Cummins 2009; Kirk 1996; Medick 1976). Changes in fertility patterns can thus be seen as part of the systematic evolution of a given sociocultural system. However, in predominantly agrarian contexts, this evolution may follow a distinct trajectory. In Guatemala, the ethnographic-demographic analysis of a peasant system demonstrated how kinship networks, extended families, agricultural labour and fertility, were tightly linked (Early, 1982). These sociocultural structures, closely linked to agrarian livelihoods and community welfare, play a key role in sustaining fertility intentions (Caldwell, 1982; Early, 1982).

The socioeconomic context, including policy mechanisms influencing adolescent reproductive behaviour, has evolved in many Global South countries. Urbanisation and female educational attainment has increased (Messerli et al. 2019, UNESCO 2023), access to sexual and reproductive healthcare services has improved (Alkema et al. 2013). These factors can influence adolescents reproductive trajectories and life aspirations and have contributed to adolescent fertility decline in many regions (Chandra-Mouli et al. 2020). While exposure to education and formal institutions can expand life options among adolescence, early childbearing persists despite broader indicators of socioeconomic progress, suggesting that fertility behaviour is shaped not only by individual characteristics but by complex sociocultural and economic systems.

While sociocultural determinants of adolescent fertility have been extensively studied, few empirical analyses have examined how different agricultural production systems serve as

proxies for distinctive local sociocultural contexts. Agricultural systems are diverse, ranging from smallholder subsistence farming to large-scale agro-export operations, and are often shaped by specific geographic and environmental conditions (Rigg 2006). In many regions of the Global South, prevailing agrarian livelihoods may be associated with specific forms of social organization and household arrangements, which can help reveal important contextual variations in demographic behaviour. These production modes reflect particular social structures, including family organisation patterns and gender roles, which may lead to varied fertility behaviours. By integrating agricultural production systems into multivariate analyses of both contextual and individual-level data, researchers can better understand how livelihood systems relate to sociocultural environments shaping adolescent reproductive outcomes.

Guatemala offers a relevant case for this study. Guatemala is a Latin American country that ranks among the top three countries of the region for high adolescent fertility and low Human Development Index (UNDP 2023; World Bank 2023). Although some authors have described its demographic transition as stalled (Grace & Sweeney 2013) with fertility patterns differing by ethnic groups (De Broe & Hinde 2006), recent fertility declines have been linked to educational factors (Grace & Sweeney 2016) and increased use of modern contraception (Grace 2010). Agriculture remains a dominant economic sector encompassing both smallholder peasant systems and large-scale monoculture practices (Krzmaric 2006). Despite some diversification into manufacturing and the tertiary sector agrarian systems remain structurally and culturally significant (Alonso-Fradejas 2012; Stanley & Bunnag 2001). Population census estimates indicate that agriculture is the major labour activity (INEC, 2019). This context presents an opportunity to examine how sociocultural contexts shape reproductive behaviour.

This research contributes to demographic theory and empirical understanding by integrating agricultural productive structures into contextual analyses of adolescent fertility. It builds upon demographic approaches that link fertility outcomes to indirect or contextual determinants and advances a novel empirical framework linking land use, sociocultural factors, and reproductive outcomes. The study enhances our understanding of fertility transitions in contexts where modernisation is partial and structurally differentiated.

## **2. Data and Methods**

This study examines two adolescent fertility outcomes: the individual probability of being a mother and municipality-level adolescent fertility rates. While individual-level analysis focuses on the likelihood of being a mother during adolescence, contextual analysis explores fertility rates and their association with indirect contextual factors. This combination allows for the identification of proximate determinants alongside broader patterns linked to place-based differences. The analysis used two different nationally representative datasets about the population characteristics and Land-use and Land-cover (LULC) data. Multivariate statistical analysis was used to model adolescent fertility outcomes and identify factors that explain differences in diverse settings.

### **2.1. Data Sources**

#### **2.1.1. Population Census**

This analysis used the 2018 population census, the most recent nationally representative dataset available (INE 2019). The census provides data on live births, household characteristics, education, and access to services. The individual-level analysis explored births among adolescents between 10 to 19 years old including 1,649,360 females in the selected age groups, enabling a disaggregated analysis of fertility patterns across different population groups. For contextual analysis, microdata was aggregated to the municipality level ( $n = 340$ ), the smallest geo-administrative unit available.

### 2.1.2. Land Use and Land Cover (LULC)

LULC raster data was used to obtain information about agricultural product categories and its territorial extension, generated by the Guatemalan Ministry of Agriculture (MAGA 2021), based on Sentinel-2A satellite imagery at 10m resolution. The raster data provides information about a range of agricultural products distributed across the country at a high spatial resolution. This data was aggregated and used to create a proxy variables representative of the predominant agricultural system at the municipal-level.

### 2.1.3. Classification of Agricultural Production Systems

Four main agricultural production systems are identified to classify municipalities according to dominant agrarian characteristics and underlying sociocultural factors, these are: agro-export monocultures, subsistence-oriented traditional agriculture, semi-commercial peasant farming, and urban/peri-urban agricultural contexts. Although these categories reflect complex sociocultural and economic dimensions, in this analysis they are identified based on Land Use and Land Cover (LULC) data at the municipal level, linking land use patterns with agrarian system typologies derived from the literature (Ellis, 2000; Bebbington, 1999). To better isolate the independent association of the agricultural typology with adolescent fertility, demographic and sociocultural variables were introduced separately.

LULC data, sourced from satellite raster imagery (MAGA, 2021), include ten categories measured as percentage shares of total municipal area: corn, horticulture, oil palm, sugarcane, banana, coffee, other permanent crops, basic grains, forest cover, artificial surfaces, and non-agricultural land such as wetlands. These variables were standardized using z-scores prior to cluster analysis to ensure comparability.

Hierarchical clustering using Ward's method and Euclidean distance identified six distinct clusters based on land cover composition. Each cluster was characterized by the dominant agricultural land uses, enabling classification into the four conceptual typologies. For instance, clusters dominated by sugarcane, oil palm, and banana were categorized as agro-export monocultures, whereas clusters with fragmented cropland and basic grains were identified as subsistence-oriented systems. Semi-commercial peasant systems corresponded to clusters with significant annual crops, coffee and horticulture shares, while urban and peri-urban areas were defined by extensive artificial surfaces and minimal agricultural land. The following summarizes the characteristics of each typology:

- Large-scale agro-export monoculture: Capital-intensive, export-oriented monocultures relying on seasonal wage labor, often under concentrated corporate ownership. Key crops include sugarcane, oil palm, and banana (Borras et al., 2011; Perfecto & Vandermeer, 2010).

- Subsistence-oriented traditional agriculture: Small, fragmented holdings focused on diversified cropping primarily for household consumption, with reliance on family labor and high ecological adaptation. The milpa system is a major example (Isakson, 2014; Zimmerer, 1996).
- Semi-commercial peasant farming: Mixed subsistence and market-oriented production, often including contract farming or cooperatives. Typical products include coffee, fruits, and horticulture (Rigg, 2006; Fisher & Victor, 2014).
- Urban and peri-urban systems: Areas with limited agricultural activity due to urbanization, dominated by built environments and service or industrial sectors (McGee, 2009).

## 2.2. Variables

### *Outcome variables*

This research explores two adolescent fertility outcomes, adolescent fertility rates and the individual probability of being a mother. Adolescent fertility rates are estimated using the number of women between 10 to 19 years old that reported a live birth in the 12 months preceding the census survey per 1,000 women in the same age group. The individual-level outcome is a binary indicator denoting whether a female aged 10 to 19 gave birth during the same reference period. This approach enables the analysis both immediate contextual factors and indirect determinants of early childbearing.

### *Explanatory variables*

The outcomes are examined using a set of explanatory variables conceptually linked to sociocultural and socioeconomic dynamics. These variables were constructed from individual and household-level information recorded during the population census. For the contextual-level analysis, census microdata was aggregated to the municipal level to generate summary indicators. This dataset was further enhanced with a proxy for agricultural production systems derived from LULC data.

At the municipal-level, the ecological analysis explores adolescent fertility rates in relation to proxy variables that indicate access to services and the exposure to education, the sociocultural context and the dominant local productive system. At the individual level the probability of giving birth in adolescence is explained by proxy variables conceptually related to life aspirations, the immediate context and access to services, including education and digital connectivity. Table 1 provides the operational framework used to organise the explanatory variables by outcome level and underlying concept.

Most explanatory variables were derived from census data. Most were directly classified or aggregated, with the exception of the unmet basic needs index, which required multivariate analysis. The ethnic composition and household structure variables reflect sociocultural context, ethnicity was derived from self-identification, while household living arrangements were classified following the UN typology (UN 2017). The socioeconomic status variable was measured using a composite index of unmet basic needs, derived via principal component analysis (PCA). Households in the lowest quintile of this index were coded as having high deprivation.

Table 1: Operational framework to explore contextual-level and individual-level adolescent fertility outcomes in Guatemala

| Outcome                                                                                         | Explanatory concept                                 | Proxy variable                                                                                                                                                                                                                     |
|-------------------------------------------------------------------------------------------------|-----------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Adolescent fertility rates<br>(Context-level)                                                   | Access to services and exposure to education system | (%) of households in lowest wealth quintile based on unmet basic needs index                                                                                                                                                       |
|                                                                                                 |                                                     | (%) of population above 23 years old attaining secondary education or higher                                                                                                                                                       |
|                                                                                                 | Sociocultural context                               | (%) of population self-identified as indigenous                                                                                                                                                                                    |
|                                                                                                 |                                                     | Male sex ratio                                                                                                                                                                                                                     |
|                                                                                                 | Local productive systems                            | (%) of households with at least one international migrant                                                                                                                                                                          |
| Probability of giving birth among females aged between 10 to 19 years old<br>(Individual-level) | Immediate sociocultural context                     | Agricultural system typology of municipality (Monoculture: palm oil/banana, Monoculture: sugarcane, Subsistence: corn /forestry, Semi-commercial: horticulture, Semi-commercial: coffee and annual crops, Urban and peri-urban).   |
|                                                                                                 |                                                     | (%) of male population employed in agriculture                                                                                                                                                                                     |
|                                                                                                 |                                                     | Ethnic background (Ladino, indigenous, other)                                                                                                                                                                                      |
|                                                                                                 |                                                     | Household structure (Nuclear, Multigenerational, Extended, Composite, Other type)                                                                                                                                                  |
|                                                                                                 |                                                     | Person responsible for household decisions (Male, Female, Both, Not reported)                                                                                                                                                      |
|                                                                                                 | Life aspirations                                    | Sex of the household head (Male, Female)                                                                                                                                                                                           |
|                                                                                                 |                                                     | Agricultural system typology of municipality                                                                                                                                                                                       |
|                                                                                                 | Access to services                                  | Civil status (Single, Married/union, Divorced/separated)                                                                                                                                                                           |
|                                                                                                 |                                                     | Current enrolment status and reason for school dropout (Currently enrolled, Achieving the desired level, drop out: lack of money or started working, drop out: not interested, drop out: family formation, drop out: other reason) |
|                                                                                                 |                                                     | Individual used internet in the past three months (yes, no)                                                                                                                                                                        |

### 2.3. Statistical analysis

This study models two adolescent fertility outcomes using Generalized Linear Models (GLMs). Descriptive statistics were used to examine central tendencies and variation across key variables. Multivariate analysis was then applied to identify the individual- and contextual-level factors associated with adolescent fertility. Multicollinearity was assessed using Variance Inflation Factors (VIFs); all values were below 5, supporting the inclusion of agricultural regime and sociodemographic indicators in the models.

At municipal level, adolescent fertility rates were model using a quasi-Poisson regression with a log link. Given the variance exceeded the mean, a quasi-Poisson model was applied to account for overdispersion. All explanatory variables were standardized prior to estimation to aid interpretation of effect sizes. The quasi-Poisson modelled adolescent fertility rates at the  $j$ th municipality ( $rate_j$ ) where  $\beta_1 \dots \beta_n$  are the estimated coefficient for the  $x_1 \dots x_n$  standardized covariates. Exponentiated coefficients are interpreted as rate ratios. The model selection was based on the lowest Akaike information criteria (AIC) since the parameters are maximum likelihood estimates. The municipal-level model is specified as:

$$y_j = \log(\text{rate}_j) = \beta_0 + \beta_1 x_{1j} + \dots \beta_n x_{nj} + e_{ij}$$

Equation 1

At the individual level, the probability ( $\pi_{ij}$ ) of giving birth was modelled using a multilevel binary logistic regression. The binary outcome indicates whether individual ( $i$ ) in municipality ( $j$ ) reported a live birth in the 12 months prior to the census. Given the hierarchical data structure, with individuals nested within municipalities ( $j$ ). A random intercept was included for municipality to capture unobserved contextual heterogeneity. The basic binary logistic regression with a canonical link  $\log\left(\frac{\pi}{1-\pi}\right)$  with an intercept  $\beta_0$  as the probability of giving birth for the individuals at the reference categories,  $\beta_1 \dots \beta_n$  are the regression coefficients,  $x_{ij}$  are the covariates,  $u_j \sim N(0, \sigma^2)$  are the normally distributed random effects of the municipalities, and  $e_{ij}$  the residual term for every woman. The individual-level model is specified as:

$$y_{ij} = \log\left(\frac{\pi}{1-\pi}\right) = \beta_0 + \beta_1 x_{1ij} + \dots \beta_n x_{nij} + u_j + e_{ij}$$

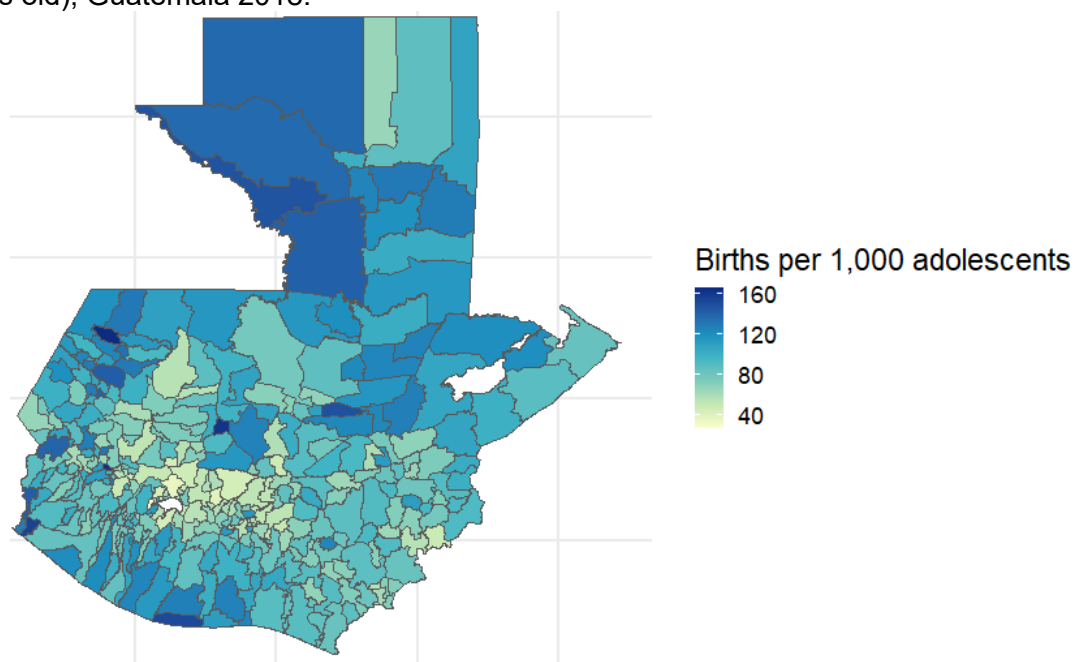
Equation 2

Intraclass correlation coefficients (ICCs) were calculated to quantify the proportion of outcome variance attributable to between-municipality differences. Model adequacy was evaluated using the likelihood ratio test for random effects, and fixed effects were tested using Wald statistics. Variance Inflation Factors (VIFs) confirmed acceptable levels of multicollinearity (< 5). All variables were centered to facilitate convergence and interpretation. The analysis was conducted using R software.

### 3. Results

This study explores two dimensions of adolescent fertility: the municipal-level fertility rate and the individual probability of early childbearing. These two outcomes allow for a complementary perspective on adolescent fertility, capturing both the influence of broader contextual structures and individual-level determinants. The average adolescent fertility rate was 88.0 live births per 1,000 females aged 10 to 19 years ( $\pm 2.7$ , CI 95%), an estimate representative of the 2018 population at the municipal level. Rates varied widely across municipalities, from 26.9 to 165.8, suggesting substantial within-country heterogeneity. A spatial representation of these differences is presented in Figure 1. The observed variation highlights the relevance of place-based factors in influencing fertility dynamics during adolescence, which are further examined through multivariate analysis

Figure 1: Adolescent fertility rates (number of live births per 1000 females between 10 to 19 years old), Guatemala 2018.



Source: Author's own analysis

Agricultural production systems emerged as one of the key contextual dimensions of interest. Land use and land cover (LULC) data reveal diverse patterns in territorial utilization across municipalities. On average, 50.6% of the municipal surface is covered by forest, 45.5% is dedicated to agriculture, and the rest corresponds to other uses, including artificial areas. Within agricultural land, crop structure reflects varying production. Annual crops represent most of the agricultural land (42.3%), maize represents 23.5% of the land use, while the most prevalent monoculture product is sugarcane (6.6%) followed by oil palm (4.1%). Agricultural products were categorised to distinguish production systems finding that Subsistence-oriented systems dominate in 61% of the municipalities followed by Semi-commercial systems, dominating in 21% of the municipalities followed by Monoculture agro-export systems and urban territories. This typology serves as a key contextual framework for examining how differentiated agrarian systems intersect with adolescent reproductive outcomes.

### 3.1. Municipal-level: Contextual predictors

Adolescent fertility rates revealed significant variation across municipalities and were associated with multiple sociocultural and agricultural context variables (See Table 1). Access to education and living conditions emerged as key factors. Higher difficulties in accessing living standards, as measured by the proportion of households with unmet basic needs, were associated with higher adolescent fertility. In contrast, a higher percentage of the adult population attaining at least secondary education was negatively associated with adolescent fertility, indicating a protective effect of education. Different from prior research, the ethnic composition, measured by the proportion of self-identified indigenous, was not significantly associated with fertility rates in this model.



Table 1: Adolescent fertility rates (number of live births per 1000 females between 10 to 19 years old) explained by sociocultural and agricultural context variables, Guatemala 2018.

| Coefficient                                                        | Incidence<br>rate ratio | CI<br>2.5% | CI<br>97.5% | P-value |
|--------------------------------------------------------------------|-------------------------|------------|-------------|---------|
| Intercept                                                          | 82.333                  | 79.805     | 84.913      | <0.0001 |
| (%) of households in lowest wealth quintile                        | 1.068                   | 1.038      | 1.099       | <0.0001 |
| (%) of the population > 23 years old attaining secondary education | 0.908                   | 0.871      | 0.947       | <0.0001 |
| (%) of population self-identified as indigenous                    | 0.981                   | 0.951      | 1.011       | 0.209   |
| Male sex ratio                                                     | 1.077                   | 1.034      | 1.122       | <0.001  |
| (%) of households with international migrants                      | 1.097                   | 1.052      | 1.143       | <0.0001 |
| (%) indigenous * (%) households with international migrants        | 1.062                   | 1.037      | 1.088       | <0.0001 |
| Subsistence: corn /forestry                                        | 1.000                   |            |             |         |
| Monoculture: palm oil/banana                                       | 1.348                   | 1.177      | 1.536       | <0.0001 |
| Monoculture: sugarcane                                             | 1.164                   | 1.083      | 1.250       | <0.0001 |
| Semi-commercial: coffee and annual crops                           | 1.047                   | 0.975      | 1.123       | 0.205   |
| Semi-commercial: horticulture                                      | 1.009                   | 0.917      | 1.110       | 0.847   |
| Urban and Peri-urban                                               | 0.967                   | 0.777      | 1.196       | 0.762   |
| (%) of male population employed in agriculture                     | 1.040                   | 0.999      | 1.082       | <0.05   |

Source: Author's own analysis

Migration-related indicators were consistently linked to higher fertility. The proportion of international migrant households and internal migrants were positively associated with adolescent fertility. The interaction between indigenous background and international migration was also significant, suggesting that the reproductive effects of transnational migration may be shaped by local cultural contexts. Sex ratio imbalances also mattered. Municipalities with a higher male-to-female ratio displayed higher adolescent fertility, potentially reflecting labour migration patterns related to local economic dynamics.

Agricultural systems were strongly associated with fertility variation. Municipalities dominated by monoculture agro-export crops had significantly higher fertility: palm oil and banana systems and sugarcane were associated with higher rates compared to the subsistence reference group. Semi-commercial systems and urban/peri-urban municipalities were not significantly different from the reference group, except for a marginal effect of male agricultural employment.

### 3.2. Individual-Level: Sociodemographic Predictors

At the individual level, multivariate analysis was conducted using a multilevel logistic regression to estimate the probability of adolescent women having given birth in the 12 months prior to the census. The model incorporated a broad range of sociodemographic predictors, including age, ethnicity, household structure, autonomy indicators, educational status, and digital connectivity. All estimates were adjusted for municipality-level clustering. Table 2 describes the factors explaining differences in the individual probabilities of giving birth.

Individual characteristics such as age and ethnicity emerged as significant predictors of adolescent motherhood. Females aged 15 had 4.28 times higher odds of being mothers, rising to 50.53 times higher by age 19, compared to girls under age 15. This increase reflects the cumulative risk of childbearing as adolescents age. Mayan indigenous adolescents were less likely to report a birth than their Ladina counterparts, as were adolescents from other ethnic groups. Mayan indigenous adolescents had significantly lower odds of reporting a birth than their Ladina peers. However, exploratory models (not shown) including only age and ethnicity

indicated a positive association between indigenous identity and adolescent motherhood. This relationship shifted in the multivariate model adjusting for contextual and socioeconomic factors, aspect that highlights the importance of structural and environmental conditions in determining reproductive outcomes among indigenous adolescents.

Table 2: Individual probability of giving birth among females between 10 to 19 years old explained by sociocultural and socioeconomic factors, Guatemala 2018.

|                                                               | <b>Coefficient</b>                 | <b>Odds Ratio</b> | <b>Low</b> | <b>High</b> | <b>P value</b> |
|---------------------------------------------------------------|------------------------------------|-------------------|------------|-------------|----------------|
| <b>Age</b>                                                    | Intercept                          | 0.001             | 0.001      | 0.001       | <0.0001        |
|                                                               | Less than 15 years old             | 1.000             |            |             |                |
|                                                               | 15 years old                       | 4.282             | 3.931      | 4.665       | <0.0001        |
|                                                               | 16 years old                       | 13.014            | 12.050     | 14.056      | <0.0001        |
|                                                               | 17 years old                       | 23.608            | 21.917     | 25.429      | <0.0001        |
|                                                               | 18 years old                       | 34.937            | 32.457     | 37.607      | <0.0001        |
|                                                               | 19 years old                       | 50.531            | 46.940     | 54.396      | <0.0001        |
| <b>Ethnic background</b>                                      | Ladino                             | 1.000             |            |             |                |
|                                                               | Mayan indigenous                   | 0.672             | 0.645      | 0.700       | <0.0001        |
|                                                               | Other                              | 0.720             | 0.643      | 0.806       | <0.0001        |
| <b>Household structure</b>                                    | Nuclear                            | 1.000             |            |             |                |
|                                                               | Multigenerational                  | 0.046             | 0.044      | 0.048       | <0.0001        |
|                                                               | Extended                           | 1.607             | 1.569      | 1.647       | <0.0001        |
|                                                               | Composite                          | 0.669             | 0.634      | 0.706       | <0.0001        |
|                                                               | Other                              | 0.050             | 0.048      | 0.052       | <0.0001        |
| <b>Person responsible for household decisions</b>             | Male                               | 1.000             |            |             |                |
|                                                               | Female                             | 1.375             | 1.321      | 1.432       | <0.0001        |
|                                                               | Both                               | 0.951             | 0.929      | 0.975       | <0.0001        |
|                                                               | Not reported                       | 1.259             | 1.166      | 1.358       | <0.0001        |
| <b>Sex of the household head</b>                              | Male                               | 1.000             |            |             |                |
|                                                               | Female                             | 1.347             | 1.303      | 1.392       | <0.0001        |
| <b>Agricultural system typology</b>                           | Subsistence: corn /forestry        | 1.000             |            |             |                |
|                                                               | Monoculture: palm oil/banana       | 1.532             | 1.241      | 1.892       | <0.0001        |
|                                                               | Monoculture: sugarcane             | 1.219             | 1.104      | 1.347       | <0.0001        |
|                                                               | Semi-commercial: coffee and annual | 1.204             | 1.090      | 1.330       | <0.005         |
|                                                               | Semi-commercial: horticulture      | 1.138             | 1.001      | 1.295       | <0.05          |
|                                                               | Urban and Peri-urban               | 1.422             | 1.153      | 1.755       | <0.005         |
| <b>Civil status</b>                                           | Single                             | 1.000             |            |             |                |
|                                                               | Divorced/separated                 | 50.698            | 49.168     | 52.275      | <0.0001        |
|                                                               | Married/union                      | 189.572           | 167.194    | 214.944     | <0.0001        |
| <b>Interaction: Ethnic background and civil status</b>        | Indigenous and divorced/separated  | 1.292             | 1.081      | 1.545       | <0.005         |
|                                                               | Other and divorced/separated       | 1.232             | 0.801      | 1.894       | 0.342          |
|                                                               | Indigenous and married/union       | 1.244             | 1.192      | 1.299       | <0.0001        |
|                                                               | Other and married/union            | 1.589             | 1.384      | 1.825       | <0.0001        |
| <b>Current enrolment status and reason for school dropout</b> | Currently enrolled,                | 1.000             |            |             |                |
|                                                               | Drop out: family formation         | 6.887             | 6.613      | 7.172       | <0.0001        |
|                                                               | Drop out: due to economic reasons  | 3.440             | 3.325      | 3.560       | <0.0001        |
|                                                               | Drop out: not interested           | 3.437             | 3.305      | 3.573       | <0.0001        |
|                                                               | Drop out: other reason             | 3.927             | 3.778      | 4.081       | <0.0001        |
|                                                               | Achieving the desired level        | 1.322             | 1.175      | 1.489       | <0.0001        |

|                                                         |              |       |       |       |         |
|---------------------------------------------------------|--------------|-------|-------|-------|---------|
| <b>Use of internet<br/>in the past three<br/>months</b> | No           | 1.000 |       |       |         |
|                                                         | Yes          | 0.755 | 0.736 | 0.774 | <0.0001 |
|                                                         | Not reported | 1.191 | 1.069 | 1.327 | <0.005  |

Source: Author's own analysis

Household structure and household leadership are sociocultural factors having a significant influence on early childbearing. Adolescents living in extended households were significantly more likely to give birth compared to those in nuclear households. Indicators of decision-making authority and household leadership also showed significant associations. Adolescents residing in female-headed households were more likely to have experienced early motherhood, and those in households where women were the primary decision-makers had similarly elevated odds. When decision-making was shared between sexes, the odds were slightly lower than in male-headed households

Agricultural production systems, used as proxies for broader contextual and economic dynamics, were also significantly associated with individual fertility outcomes. This research identified that those adolescents living in areas dominated by monoculture banana and palm oil systems had 53% higher odds of early motherhood and those in sugarcane regions had 22% higher odds compared to adolescents living in municipalities characterized by subsistence-oriented systems. Adolescents in semi-commercial coffee and annual crop systems, and those in horticultural areas, also exhibited higher probabilities of being mothers. Yet adolescents in urban and peri-urban municipalities had significantly elevated odds, indicating that fertility risks are not restricted to rural or agrarian zones.

Variables conceptually related to life aspirations, particularly the civil status are among the most relevant explanatory factors. Adolescents in a marital or consensual union at the time of the interview had higher odds of giving birth compared to single civil status. These effects were further explained by ethnic interactions. Indigenous adolescents in marriage or unions had 1.244 times higher odds of being mothers compared to non-indigenous adolescents in similar unions. Among separated or divorced adolescents, only indigenous girls showed significantly higher odds compared to the reference.

Adolescents currently enrolled in school had the lowest probability of giving birth. Those who had dropped out due to family formation intentions had nearly 7 times higher odds of being mothers than adolescents enrolled in school. Adolescents who left school due to economic reasons, lack of interest, or other personal reasons also had significantly higher odds. Even those who reported achieving their desired educational level had moderately higher odds of early motherhood. Finally, adolescents who reported using the internet in the three months prior to the census had significantly lower odds of early childbearing compared to those not having used internet. This variable may proxy access to information, peer networks, or exposure to alternative social norms that delay family formation.

#### 4. Discussion

This study explored adolescent fertility in Guatemala influenced by factors that describe the sociocultural system, including agricultural production. Findings from both individual-level and municipal-level models suggest that adolescent fertility is influenced not only by personal characteristics and immediate household contexts, but also by macro-level dynamics, including agricultural production systems, disparities in access to education, and demographic

patterns across municipalities. These findings highlight the relevance of the contextual dynamics in shaping reproductive behaviour.

An important contribution of this study is the identification of a consistent association between municipalities dominated by monoculture agriculture and higher adolescent fertility rates. These labour-intensive agrarian areas are centred on crops such as African oil palm, sugarcane and banana. The expansion of these agricultural systems in recent decades has been linked to internal displacement and the erosion of subsistence livelihoods among peasant communities (Mingorría et al. 2014), processes that increase social and economic vulnerability. Reports of poor labour protections, including child labour and human rights violations, are common in these contexts (Carte et al. 2019; Dürr 2007; Mingorría 2017). Additionally, the predominance of a male-dominated temporary workforce may reinforce traditional gender roles, and when combined with poverty, can exacerbate the structural conditions that limit young women's autonomy. In these settings, higher adolescent fertility may reflect constrained reproductive agency.

In contrast to monoculture, municipalities with semi-commercial agricultural systems also show elevated adolescent fertility rates relative to subsistence-based areas, though less markedly. Coffee-producing regions, often in highland areas with mixed economies, may reflect vulnerabilities linked to labour dynamics, migration, and persistent poverty. While horticultural zones, typically closer to urban markets may reflect transitional contexts (Fischer & Victor, 2014; Alonso-Fradejas, 2012). Urban and peri-urban municipalities show also high adolescent fertility rates, in these settings is hypothesised that life aspirations and the immediate environment have a role in early childbearing. Further research is needed to clarify the mechanisms at play in these diverse contexts.

Sociocultural dynamics play a critical role in shaping adolescent fertility patterns. While the association with agricultural production exemplifies this influence, other sociodemographic factors commonly found in agrarian settings remain central. Social norms and family formation function as key mechanisms. Household dynamics revealed important associations with adolescent fertility. Adolescents living in female-headed households or in households where women were the primary decision-makers were more likely to have experienced early motherhood. These findings are consistent with Guatemala's highly matrifocal families, where norms around early family formation may be more common by the extended kin (Carter 2004; Maupin & Hackman 2019).

The analysis also confirms that household composition represents a significant mediator, adolescents living in extended or composite households were more likely to report a live birth. This household structure represents nearly one-third of all households in Guatemala, although it may offer a functional support network (Sear 2017; Mokomane 2013), they may also reflect environments where early unions and childbearing are frequent, especially in contexts with limited access to education or employment (Samandari & Speizer 2010). More research is needed to understand how different configurations of authority and support can influence reproductive behaviours among adolescents.

Life aspirations, especially those linked to education, remain central factors of adolescent fertility. This analysis show that a high proportion of adolescent mothers were already in union at the time of the census, underscoring the central role of early marriage and family formation

in shaping fertility outcomes, similar finding previously reported (Lloyd & Mensch 2008). Being enrolled in school during adolescence was strongly linked to lower chances of early childbearing, supporting the idea that staying in school delays unions and enables future goals (Bongaarts 2003; Murphy-Graham et al. 2020). In contrast, school dropouts, for different reasons were associated with higher fertility. Dropping out due to economic hardship, lack of interest, or starting a family are reasons associated to higher rates of early childbearing.

The relationship between ethnicity and adolescent fertility was complex. Unlike previous research conducted in Guatemala, indigenous adolescents were slightly less likely to report a birth than their non-indigenous peers, after accounting for individual and municipal-level factors. However, interaction effects showed that being in a union was more strongly linked to adolescent childbearing among indigenous adolescents. This suggests that social norms around unions and childbearing may vary across ethnic groups, possibly reflecting different marriage practices or family expectations. In some settings, ethnic identity, access to education, agricultural labour conditions, and household structure may overlap to shape reproductive behaviour.

The negative association between internet access and adolescent fertility may highlight the role of digital connectivity in expanding access to information, shaping aspirations, and exposing adolescents to alternative ideas and norms (Fletcher & Sarkar 2015). In settings where traditional expectations remain strong, internet use could contribute to changing social environments that influence reproductive behaviour. While the statistical association between international migration and adolescent fertility was significant, the underlying mechanisms remain unclear. It is hypothesized that factors such as shifts in household roles or changes in economic behaviour may influence adolescents reproductive behaviour. Together, migration and internet access may reflect broader global processes that are reshaping fertility patterns at the local level. Further research is needed to better understand these dynamics.

There are indicators that Guatemala has undergone several socioeconomic changes in recent years, including the expansion of non-agricultural labour markets, increased international migration, policy reforms raising the minimum age for marriage, and higher secondary school attendance. These factors are likely to contribute to declines in fertility, especially among adolescents. These shifts reflect broader transformations associated with a dual economy, where modern and traditional systems coexist. However, contextual factors, particularly those related to family structures and local production systems continue to influence fertility patterns. In many agrarian areas, the family remains a central institution for social support and economic security, and this sociocultural system may continue to sustain fertility levels in certain regions.

While this study provides important insights into the structural determinants of adolescent fertility, several areas offer opportunities for further research. The cross-sectional design limits causal inference but offers a strong basis for identifying key associations. The agricultural typology, though empirically grounded, may not fully reflect the cultural and normative dimensions of territory, suggesting the value of complementary ethnographic approaches. Likewise, while the census captures household structure, it does not measure intra-household dynamics such as coercion or unequal gender expectations, which have been linked to adolescent pregnancies in the Latin American context (Sámano et al. 2017). Additionally, place-based fertility measures may not fully capture adolescent fertility dynamics, as social influences, mobility, and diverse local contexts often extend beyond administrative

boundaries. Future research using longitudinal or mixed-method designs could deepen understanding of how structural conditions intersect adolescent fertility. Nevertheless, this analysis provides relevant empirical evidence for advancing research on the determinants of adolescent fertility.

## 5. Conclusion

Adolescent fertility in Guatemala is closely linked to broader sociocultural systems in which agricultural production, family organization, social norms, and expectations around family formation are intertwined, shaping reproductive behaviour through distinct mechanisms. Different agricultural systems shape adolescent fertility through distinct pathways. Higher fertility rates in agro-export monoculture areas likely reflect increased social and economic vulnerabilities, such as labour precarity and displacement, rather than the social structures typical of subsistence-based systems. Despite these differences, family remains a central institution across geographic areas, likely providing social support and economic security. Persistent family arrangements, social norms, and early marriage practices continue to influence reproductive outcomes. The complex interplay between labour dynamics, family structure, ethnic identity and life aspirations illustrates how structural and cultural factors combine to influence adolescent fertility, particularly in settings marked by uneven modernization. Understanding fertility patterns requires attention to how local production systems and sociocultural arrangements generate environments that either constrain or enable reproductive choices. This perspective emphasizes the need to view adolescent fertility not merely as an individual outcome, but as within broader structural and social systems.

## 6. References

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