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### Abstract

This study aimed to analyse, using open-source data from Brazil, the impact of high school full time on the odds of early childbearing in Amazonian municipalities. The final dataset comprised 359 observations spanning 62 municipalities in Amazon, covering the period from 2010 to 2015. The methodology employed was a Generalised Linear Mixed Model (GLMM). Overall, municipalities with enrolments in high school full time are negatively correlated with the log-odds of the early pregnancy rate among girls between 15 to 19 years old. The odds ratio calculated is lower than one (0.95), meaning that when the municipality has enrolments in high school full time, the odds of early childbearing are likely to decrease in 4,41%. This relationship is particularly significant in low-to-medium income municipalities: the calculated odds ratio is lower than one in both models (between 0.92 and 0.93), and there is a 7.88% and 7.01% decrease in the odds of early pregnancy for respectively low-income and medium-income municipalities when the dummy for enrolments in high school full time is equal to one. However, these findings are merely suggestive and somewhat inconclusive. Challenges in modelling and methodology, alongside significant difficulties in data collection, undermine the robustness of this study, necessitating cautious interpretation of its results. Future research could benefit from employing alternative methodologies, such as causal inference models or qualitative methods, to achieve more robust findings. Additionally, the collection of primary data on social norms and religion is recommended, as these factors could significantly enhance the understanding of the determinants of early fertility within the Brazilian context.

*Keywords:* full-time high school, early childbearing, Amazon, GLMM, Brazil, fertility decision-making.

# Fertility Decision-Making in Brazil: Impact of High School Full Time on the Prevention of Early Pregnancy among Young Women in Amazon

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I firmly believe that education is the remedy for all human suffering, ranging from individual low self-esteem to macroeconomic issues such as poverty and structural inequality. Education sets you free and enables you to operate at the highest of your potential – both personally and professionally. I am very grateful to have had the opportunity to conduct this research in The Department of Psychological and Behavioural Sciences, being another Brazilian student putting the issues of the Global South into perspective at one of the most prestigious universities in the world. It is an honor, and not even in my wildest dreams could I have imagined reaching this point. But here I am.

Thank you LSE, for the space. In these 40 pages lies the growth I have experienced over one year of my master's program, during which I had the opportunity to open my mind to different cultures, societies, and beliefs. I feel as though I have aged 20 years in just one. And despite all the learning, I feel I have learned only 1% about the world. In these 40 pages, I hold all my desire to continue growing and learning about my own smallness in the face of a world so vast, complex, and, sometimes, beautiful. Thank you. I am looking forward to seeing you soon.

## Introduction

### Motivations

In Brazil, 1,043 teenagers become mothers every day. This translates to 44 babies being born to young women in the country every hour, and on average, two of these young mothers are between 10 and 14 years old<sup>1</sup>. Although teenage pregnancy has decreased in recent years<sup>2</sup>, the absolute numbers related to this issue are still a concern and far from the ideal scenario, posing obstacles to Brazil's socioeconomic development.

Recent news from Folha de São Paulo<sup>3</sup> reported high levels of early pregnancy in the Northern region of the country, comparable to Sub-Saharan Africa, with 4.72 pregnancies per thousand girls aged 10 to 14. This rate far exceeds the national average of 2.14. Low adherence to contraceptive methods, lack of access to information and education, high rates of sexual violence, and difficulties in accessing health services are possible causes of this alarming situation in the region.

Among those possible causes, this work focuses on the relationship between education and early pregnancy prevention. School attendance and access to educational opportunities are strong determinants of lower pregnancy rates and the literature shows that women who remain longer at school significantly reduce her chances of early motherhood (Rodríguez Ribas, 2021; Glassman et al., 2012).

Given this context — and the lack of scientific evidence for Brazil — this study aims to analyse early pregnancy in the context of Amazon by investigating how enrolments in high school full time are correlated with the early pregnancy rate, calculated for the state of Amazon, an under investigated area.

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<sup>1</sup> Per hour, 44 babies are born to teenage mothers in Brazil, according to data from SUS. (n.d.). Brazilian Hospital Services Company. <https://www.gov.br/ebserh/pt-br/comunicacao/noticias/por-hora-nascem-44-bebes-de-maes-adolescentes-no-brasil-segundo-dados-do-sus>

<sup>2</sup> Peres, S. (2024). The number of women becoming mothers after 40 is increasing. Poder360. <https://www.poder360.com.br/brasil/crece-numero-de-mulheres-que-se-tornam-maes-com-mais-de-40-anos/>

<sup>3</sup> Early pregnancy in Northern Brazil has a rate comparable to that of sub-Saharan Africa. (2024, March 28). Folha de S.Paulo. [https://www1.folha.uol.com.br/equilibriosaude/2024/03/gravidez-precoce-no-norte-do-brasil-tem-indice-comparavel-ao-da-africa-subsaariana.shtml?utm\\_source=whatsapp&utm\\_medium=social&utm\\_campaign=compwa](https://www1.folha.uol.com.br/equilibriosaude/2024/03/gravidez-precoce-no-norte-do-brasil-tem-indice-comparavel-ao-da-africa-subsaariana.shtml?utm_source=whatsapp&utm_medium=social&utm_campaign=compwa)

Thus, the research question is: " Is there any difference in the odds of early pregnancy behaviour, when comparing amazonian municipalities with enrolments in high school full time to those without?". This work aims to contribute to the literature on sexual behaviour and economic development in Brazil, with a focus on public policies related to education.

### **Why should we worry about early pregnancy behaviour?**

Latin America and the Caribbean (LAC) is the second region after Africa experiencing the highest rates of teenage pregnancy globally. In fact, 68 births per 1000 women are from girls aging between 15 to 19 years old (United Nations, 2013). For instance, Argentina's Northeast region and Brazil's Northern region have early pregnancy rates comparable to those in Sub-Saharan Africa, with sharp increases since 2003 (Alzúa & Velázquez, 2017).

The literature on early childbearing in the region provides evidence of a systematic link between being a teenage mother and experiencing poorer outcomes in various life dimensions. Educational achievements, access to the labour market, and the development of socio-emotional skills are some examples cited (Sánchez & Favara, 2019, p. 12). Indeed, teenage pregnancy negatively impacts both the mother and the child's upbringing, especially in developing countries (Sánchez & Favara, 2019, p. 11; Azevedo et al, 2012).

In the Brazilian context, teenage pregnancy is a strong predictor of school dropout. Young poor girls are at high risk of being caught in an intergenerational cycle of poverty: early mothers with low education giving birth to future early mothers with low education (Souza, 1998; Gupta, 2000; Heilborn et al., 2007; Almeida & Aquino, 2009; Cruz et al., 2021).

In Peru, females who are victims of teen marriage, cohabitation, and parenthood (TMCP women) are less likely to be enrolled in or complete formal education. They also experience reduced prospects of securing a formal job, increasing their chances of becoming NEET individuals – not in education, employment, or training – by the age of 22 (Balarín et al., 2017; Sánchez & Favara, 2018; Franco and Ñopo, 2018; Briones & Porter, 2019).

According to Eggleston et al., 2000, 37% of Jamaican women gets pregnant at least once before the age of 20 and 81% of those pregnancies are not planned. Unwanted pregnancies are

also a reality in Mexico, being higher among adolescents: 42% of teenage pregnancies are not planned or desired, according to Gutiérrez Vázquez & Parrado, 2016.

Moreover, young childbearing is still a concern in Mexico, even with declines in the fertility rate, going from 6,5 in 1970 to 2.2 in 2010. The mean age in the country for the first child was 21 between 1992 and 2006 and around 16% of women have their first child before the age of 18 (Gutiérrez Vázquez & Parrado, 2016).

The younger individuals initiate intimate relationships, the less likely they are to use contraception, thus increasing their risk of pregnancy and STDs occurrence (Eggleston et al., 2000). Hence, premature sexual intercourse can indicate significant public health issues and deficiencies in human development, requiring the attention of policymakers.

Since 1990, major international organizations – such as the World Bank, UNICEF, and UNESCO – have been reporting scientific findings suggesting that women are among the main drivers of socioeconomic development and intergenerational wealth (World Bank, 1995, 2000, 2019; UNESCO, 2010, 2020; UNICEF, 2015). Specifically, women's education is a key component in eradicating poverty and improving child health and literacy, especially for daughters (Khalid, 2023; Akram and Pervaiz, 2020; King and Hill, 1993).

Hence, there are strong arguments supporting public policies to enhance educational resources for women and girls and prevent early childbearing. As forecasted, these measures are crucial for human development. Nevertheless, action is better taken under scientific production.

In this way, this study has the intention of better inform which pedagogical regime is more efficient and suitable for promoting economic development and greater opportunities for vulnerable populations in Brazil, in order to enhance social well-being. Also, it provides informational content for Amazon, which can be used in complementary policies.

### **The Life History Theory Approach applied to Early Childbearing**

The study of fertility in Economics is often viewed as a matter of rational decision-making, particularly in the context of developed industrialized societies where access to contraception is more prevalent (Aizen & Klobas, 2013). However, it is unrealistic — from a

social justice perspective — to consider fertility solely as a rational choice.

Strong social forces — such as gender roles, taboos against abortion and early marriage — can influence sexual behaviour and chance might play a role in determining the number of births per women. Sexual violence and unplanned pregnancies are not only a reality worldwide, but also hold significant relevance in emerging and underdeveloped countries (Ajayi & Ezegbe, 2020; Abera et al., 2020; Palacios-Perdomo & Acosta-Ramírez, 2021; Sarder et al., 2021; Ayalew et al., 2022; Kågesten et al., 2016; Becker, 1960).

Given this context, decisions in fertility might not be fully comprehended through the lens of economic rationality alone. Factors such as income, education, access to health services, values, social norms and public policies interact considerably with the intentions in fertility (Heilborn et al., 2007; Asma Pourtaheri et al., 2024; Ayalew et al., 2022; Achen et al., 2021; Sarder et al., 2021).

Therefore, an early pregnancy may not solely result from individual willpower and reasoning. It is inherently linked to a psychosocial and economic infrastructure that shapes perceptions and intentions.

The interaction between macroeconomic conditions and individual behavioral outcomes is extensively discussed within the Life History Theory Approach (Mittal & Griskevicius, 2014; Kaplan & Gangestad, 2005). In this theoretical framework, perceptions of control are the primary psychological mechanism influencing whether individuals adopt a fast or slow life history strategy.

Perceptions of control refer to individuals' beliefs about their ability to shape their own lives (Gaucher & Galinsky, 2009; Mittal & Griskevicius, 2014). Individuals with different childhood socioeconomic backgrounds may perceive economic uncertainty in different ways, leading to varied perceptions of control.

Typically, lower socioeconomic status decreases one's perception of control over the environment, leading to what is called a fast life strategy. In such cases, it is challenging to delay gratification and adopt a long-term life perspective. Impulsive and risky behaviours might arise as



a survival response to environmental instability (Mittal & Griskevicius, 2014; Belsky, 2012; Nettle, 2010; Ellis, Figueredo, Brumbach, & Schlomer, 2009; Figueredo, Vásquez, Brumbach, & Schneider, 2004).

A life strategy refers to the manner in which an individual addresses and resolves the trade-offs inherent in existence, characterized by activities that must be prioritized and efficiently integrated within the context of their living conditions. Fast life strategies are typically the adaptive response to hostile and unpredictable environments.

Given the uncertainty, delaying future rewards does not appear to be a prudent strategy — there is no assurance that these rewards will materialize in the future. In such contexts, individuals adapt to a more accelerated pace, where the odds of early reproduction are higher (Mittal & Griskevicius, 2014; Belsky, Schlomer, & Ellis, 2012; Simpson, Griskevicius, Kuo, Sung, & Collins, 2012; Del Giudice, Ellis, & Shirtcliff, 2011; Nettle, Coall, & Dickins, 2011).

Fast life strategies that emerge in economic uncertainty are also characterized by high levels of perceived extrinsic threats. An extrinsic threat is equally shared by all members of a population and creates a sense of loss of control – hence, no amount of somatic investment can enable an individual to escape the perceived danger (Mittal & Griskevicius, 2014; Quinlan, 2010).

This study hypothesizes that this theoretical pathway describes the situation of municipalities in the Amazon region, particularly in the case of early pregnancy. The environment of socioeconomic instability undermines the perception of control over fertility decisions, as the environment can favour a fast life strategy, and extrinsic threats might be the norm.

However, education, especially full-time education – where more time is dedicated to academic achievements – is expected to have the capacity to alter an individual's perceptions of control. It is hypothesized that full-time high school education can, therefore, alter the perception girls have of a hostile environment, transforming a sense of extrinsic threat into an intrinsic one.

An intrinsic threat is not shared by all members of a population and provides the individual with a greater sense of agency: they come to believe that somatic investments are worth the effort in the face of uncertainty (Mittal & Griskevicius, 2014; Quinlan, 2010). Thus,

full-time education may have a greater chance of promoting a slow life strategy within an unstable economic environment.

Slow strategists prioritize somatic efforts over reproductive efforts, being associated with later sexual maturation and delayed reproduction. Hence, the hypothesis of this study is stated as:

**H<sub>0</sub>:** there is no difference in the odds of early pregnancy between municipalities with enrolments in high school full time and those without enrolments in high school full time.

**H<sub>1</sub>:** there is a difference in the odds of early pregnancy between municipalities with enrolments in high school full time and those without enrolments in high school full time.

### **Data and Methodology**

#### **Data**

The dataset used in this analysis was independently created using R software. All data are publicly available and were collected from various Brazilian sources. The original dataset was a panel covering the period from 2010 to 2019 for municipalities in the Amazon region, comprising 620 observations. However, the final results utilized a shorter dataset spanning from 2010 to 2015, summarizing 359 observations for the Amazon municipalities.

The choice to use a shorter dataset was influenced by several factors. Firstly, the Human Development Index (HDI) at the municipality level is only available up to 2016. The decision to retain the HDI indicator is supported by the results of Pearson's coefficient and correlation test, which showed a strong negative linear correlation with the dependent variable, with a coefficient significantly different from zero. Additionally, the HDI variable had some missing values, which were subsequently removed from the dataset.

Secondly, literature on early childbearing in Brazil identifies access to health services as a significant predictor of teenage pregnancy (Nascimento et al., 2021; Dos Santos et al., 2021). However, the proxy for this indicator — “primary health care coverage” — is only available until 2015 in DATASUS, Brazil's primary open-source health data platform. Therefore, to create a more balanced dataset, data from the year 2016 was excluded from the final analysis.

The dependent variable was calculated using public data at the municipality level from the

DATASUS platform. As described in the table below, “early pregnancy” is defined as a girl who became pregnant between the ages of 15 and 19, which corresponds to the typical high school age range. The rate was calculated as in Benevides et al. (2024). The independent variable was initially a count data: the number of high school full-time enrolments per municipality per year, extracted from Censo Escolar, the main Brazilian database for educational data.

Almost all control variables can be found in Benevides et al. (2024) for the Brazilian context. One significant challenge was controlling for sexual violence impacting teenage pregnancy, a particularly relevant issue in the Amazon region. Recent news from major Brazilian media outlets have reported that 7 out of 10 victims of sexual violence against women in the Legal Amazon region are aged 14 or younger<sup>4</sup>, and over 70% of violence cases against minors in Amazon involve female victims<sup>5</sup>.

However, accessing this type of data is very challenging due to under-reporting and the sensitive nature of the context, especially in Amazon (Maia & Barreto, 2012). To address this issue, variables representing the proportions of males and females were included, given the associations between unbalanced sex ratios and varying levels of violence. However, this relationship often yields inconclusive or mixed results in the literature and most studies are focused on the Global North (Barber, 2014; Diamond-Smith & Rudolph, 2018; Blanchard & Centifanti, 2020; Pabst et al., 2022; Salas-Rodríguez et al., 2022).

Nonetheless, men are the primary sociodemographic group associated with risky sexual behaviour and the incidence of STDs in the Amazon context (Pedroso, 2022). To incorporate the sex ratio could be a useful alternative to capture instances of sexual violence and differences in sexual behaviour between genders.

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<sup>4</sup> Globo. (2024, March 18). 7 out of 10 victims of violence against women in the Legal Amazon are up to 14 years old, according to research. G1. <https://g1.globo.com/meio-ambiente/noticia/2024/03/18/7-em-cada-10-vitimas-de-violencia-contra-mulher-na-amazonia-legal-tem-ate-14-anos-aponta-pesquisa.ghtml><https://www.gov.br/ebserh/pt-br/comunicacao/noticias/por-hora-nascem-44-bebes-de-maes-adolescentes-no-brasil-segundo-dados-do-sus>

<sup>5</sup> Globo. (2023, July 30). More than 70% of cases of violence against minors in AM are recorded among female victims. G1. <https://g1.globo.com/am/amazonas/noticia/2023/07/30/mais-de-70percent-dos-casos-de-violencia-contra-menores-no-am-sao-registrados-em-vitimas-do-sexo-feminino.ghtml>

**Table 1. Table of Variables**

Variable	Source	Data type	Description	Literature
<b>Dependent variable</b>				
Early Pregnancy Rate (15 to 19 years old)	DATASUS	Open Source	$\frac{\text{Live Births}_{\text{teens}} + \text{Fetal Deaths}_{\text{teens}}}{\text{Total Live Births} + \text{Total Fetal Deaths}}$	Benevides et al. (2024)
<b>Independent Variable</b>				
Enrolments in High School full-time	CENSO ESCOLAR (INEP)	Open Source	The number of enrolments in High School full-time per municipality per year.	Benevides et al. (2024); Berthelon & Kruger (2011)
<b>Controls</b>				
High School Failure Rate	INEP	Open Source	Percentage of students who failed High School per municipality per year.	Benevides et al. (2024)
High School Dropout Rate	INEP	Open Source	Percentage of students who dropout High School per municipality per year.	Benevides et al. (2024); Souza (1998); Gupta (2000); Heilborn et al. (2007); Almeida & Aquino (2009); Cruz et al. (2021)
GDP per capita	IBGE	Open Source	GDP per capita per municipality at current prices.	Benevides et al. (2024)
FIRJAN Human Development Index	IPEADATA	Open Source	Human Development Index per municipality	Benevides et al. (2024)
Proportion of Males	DATASUS	Open Source	The proportion of males per municipality per year.	Barber (2014); Diamond-Smith & Rudolph (2018); Blanchard & Centifanti (2020); Pabst et al. (2022); Salas-Rodríguez et al. (2022)
Proportion of Females	DATASUS	Open Source	The proportion of females per municipality per year.	Barber (2014); Diamond-Smith & Rudolph (2018); Blanchard & Centifanti (2020); Pabst et al. (2022); Salas-Rodríguez et al. (2022)

## Methodology

The primary methodology chosen to analyse the relationship between full-time high school enrolments and early pregnancy rates was a Generalized Linear Mixed Model (GLMM) with Beta family estimators. This model is suitable for panel data, accounting for both fixed and random effects, and it is flexible enough to accommodate different distributions of the dependent variable (Hunger et al., 2012). Indeed, preliminary analysis of the early pregnancy rate indicated non-normality of the data, despite being reasonably symmetric and slightly peaked. The preliminary analysis graphs can be accessed in the appendix.

A Beta Regression Model (Ferrari & Cribari-Neto, 2004) is particularly suitable when the outcome variable is a rate within the open interval (0, 1), indicating that neither 0 nor 1 are

included in the variable's distribution. In this case, the minimum early pregnancy rate in the sample is 0.19 and the maximum is 0.43, making a Beta estimator an appropriate choice. Below, there is a theoretical framework of the estimated linear regression using the R software.

$$\text{logit}(\mu_i) = \log\left(\frac{\mu_i}{1 - \mu_i}\right) = \beta_0 + \beta_1 \cdot \text{high school full time}_i + \beta_2 \cdot \text{year}_t + Z\gamma + u_i + \varepsilon_{it} \quad (1)$$

In which:

- $\mu_i$  is the mean of the outcome variable for the  $i$ -th municipality.
- High school full time $_i$  is a dummy variable that equals 1 if the  $i$ -th municipality has enrolments in full-time high school, and 0 otherwise.
- Year $_t$  represents the time component to account for year-specific effects.
- $Z_i\gamma$  includes the covariates presented above for each municipality.
- $u_i$  is the random effect capturing municipality-specific random variations.
- $\varepsilon_{it}$  is the random error term for municipality  $i$  in year  $t$ .

For this study, the chosen link function was a logit function following Ferrari & Cribari-Neto (2004). A logit link function is specifically designed to handle proportions and it transforms the outcome variable so that the relationship between the predictors and the log-odds of the dependent variable is linear, thereby improving the model's accuracy and fit. Directly modelling the outcome variable, without a link function, can result in predictions outside the (0, 1) interval, leading to biased parameters that inadequately explain the phenomenon.

Building on the proposed methodology, the next section presents an investigation into the key question of this study. Specifically, it examines how the presence of enrolments in full-time high school, compared to conventional high school education, is associated with the teenage pregnancy rate, while also controlling for additional socioeconomic and educational variables.

## Results

### GLMM with Beta family estimators with income levels

The preliminary analysis of the data revealed a predominantly non-normal and heteroscedastic sample with the presence of outliers. The dataset is explosive in nature, which may reflect the extremely unequal reality of Amazon. To avoid further informational loss, outliers were not removed from the database. Instead, the sample of 359 observations was divided into three sub-samples based on GDP per capita, resulting in three models: low income, middle income, and high income, all estimated using the GLMM model with Beta family estimators. The aim of this division was to create sub-samples that could group more homogeneous municipalities.

To obtain more interpretable results, the estimated coefficients presented in the following tables were transformed into their exponential form. Consequently, the results are expressed as odds ratios. An odds ratio less than one indicates a negative relationship between the variables, suggesting a decrease. An odds ratio equal to one indicates a neutral impact, implying no effect. Conversely, an odds ratio greater than one indicates a positive relationship between the variables, suggesting an increase. Below is a table to help guide the understanding of the results presented.

**Table 2. Interpretation with odds ratio**

Condition	Sign of the association	Meaning
Odds ratio < 1	Negative	There is an estimated decrease
Odds ratio = 1	Negative or positive	Neutral impact/no effect
Odds ratio > 1	Positive	There is an estimated increase

The estimated percentage change in the odds of early childbearing giving the impact of the main independent variable was also calculated following the equation below:

$$\text{Estimated percentage change of } x \text{ in } y = (1 - \text{odds ratio of } x) \times 100 \quad (2)$$

*Low to medium income municipalities*

The results for low-income and medium-income municipalities were grouped together due to similarities in the outcomes. Low-income is a municipality which its GDP per capita at current prices is between R\$ 3,137 to R\$ 5,610 – £ 447 to £ 799, using the most recent exchange rate in 2024. On the other hand, medium-income is a municipality which its GDP per capita at current prices is between R\$ 5,633 to R\$ 7,749 – £ 802 to £ 1,104, using the most recent exchange rate in 2024.

The calculated odds ratio for the dummy of enrolments in high school full time is lower than one in both models (between 0.92 and 0.93), indicating a negative relationship between enrolments in high school full time and the log-odds of the early pregnancy rate. When the municipality has enrolments in high school full time – thus, the dummy is equal to 1 – there is a 7.88% decrease in the odds of early pregnancy among 15 to 19 years old for low-income municipalities.

The estimated percentage for medium-income municipalities drops to a 7.01% decrease. Hence, enrolments in high school full time can reduce the chances of early childbearing in those municipalities, and this relationship is significant at 5%.

The calculated odds ratio is lower than one for dropouts in high school in medium-income municipalities, indicating a negative relationship between dropouts in high school and the log-odds of the early pregnancy rate. Hence, dropping out high school is reducing the chances of early childbearing, and this relationship is significant at 5%.

This outcome is definitely challenging to explain and requires more detailed data to further comprehension, since this scenario might be signalling omitted variable bias. The association between high school dropout rate and early pregnancy is usually positive in the literature, even though the direction of the correlation is not clear (Stoner et al., 2019).

**Table 3. GLMM Model Summaries for Low to Medium Income Municipalities**

Predictors	Low Income			Medium Income		
	Estimates	std. Error	<i>p</i>	Estimates	std. Error	<i>p</i>
Intercept	-7.14	1.68	<b>&lt;0.001</b>	-6.54	2.07	<b>0.002</b>
High School Enrollments (Dummy)	-0.08	0.04	<b>0.020</b>	-0.07	0.03	<b>0.027</b>
Log GDP per Capita	0.12	0.10	0.230	0.16	0.18	0.364
High School Failures	-0.04	0.37	0.907	-0.26	0.30	0.380
High School Dropouts	0.24	0.39	0.534	-0.87	0.39	<b>0.027</b>
HDI Index	0.21	0.32	0.506	0.41	0.32	0.200
Proportion of Males	9.95	2.94	<b>0.001</b>	8.15	2.37	<b>0.001</b>
Primary Health Care Coverage	0.02	0.07	0.706	-0.05	0.08	0.515
<b>Random Effects</b>						
$\sigma^2$		-0.01			-0.01	
$\tau_{00}$ (year)		0.00			0.00	
		0.02 (municipality)			0.01 (municipality)	
ICC		1.38			5.78	
N (year)		6			6	
		45 (municipality)			49 (municipality)	
Observations		118			119	
Marginal $R^2$ / Conditional $R^2$		0.410 / 1.224			0.818 / 1.870	

The calculated odds ratio is extremely high for proportion of males in both models, indicating a strong positive relationship between this variable and the log-odds of the early pregnancy rate between 15 to 19 years old. For each additional unit in the proportion of males, the odds of early childbearing can increase significantly in municipalities with low to medium income levels, and this relationship is significant at less than one 1%.

The model with the proportion of females is available in the appendix, as including both variables in the model would result in multicollinearity issues. However, when substituting for females, the odds ratio for this variable is extremely low, indicating a strong negative relationship between the proportion of females and the log-odds of the early pregnancy rate among 15 to 19-year-olds in both low-income and medium-income municipalities.

For each additional unit increase in the proportion of females, the odds of early childbearing can decrease significantly in these municipalities, and this relationship is significant



at the less than 1% level.

### *High-income municipalities*

The results for high-income municipalities are presented in the table below. High-income is defined as a municipality with a GDP per capita at current prices between R\$ 7,604 and R\$ 56,055 – £1,086 to £8,012, using the most recent exchange rate in 2024. There is no statistically significant variable predicting the variance in the log-odds of the early pregnancy rate among girls aged 15 to 19 in this model. The proportion of males is significant only at the 10% level, and the calculated odds ratio is still extremely high. However, this result is only suggestive, and a more conservative approach would discard this outcome.

**Table 4. GLMM Model Summaries for High Income Municipalities**

Predictors	High Income		
	Estimates	std. Error	<i>p</i>
Intercept	-3.23	1.78	0.070
High School Enrollments (Dummy)	-0.03	0.03	0.394
Log GDP per Capita	-0.03	0.05	0.602
High School Failures	-0.36	0.38	0.343
High School Dropouts	-0.26	0.35	0.454
HDI Index	-0.13	0.28	0.639
Proportion of Males	5.27	3.01	0.080
Primary Health Care Coverage	-0.01	0.09	0.923
<b>Random Effects</b>			
$\sigma^2$		-0.00	
$\tau_{00}$ (year)		0.00	
$\tau_{00}$ (municipality)		0.01	
ICC		1.41	
N (year)		6	
N (municipality)		30	
Observations		122	
Marginal $R^2$ / Conditional $R^2$		0.328 / 1.275	

### *Global Model*

A Global model, without income ranges, was performed in order to achieve a broader understanding of the data. As the table below shows, the dummy for enrolments in high school

full time is negatively correlated with the log-odds of the early pregnancy rate among girls between 15 to 19 years old, and this relationship is significant at 5%. The odds ratio calculated is lower than one (0.95), meaning that when the municipality has enrolments in full time high school, the odds of early childbearing are likely to decrease in 4,41%.

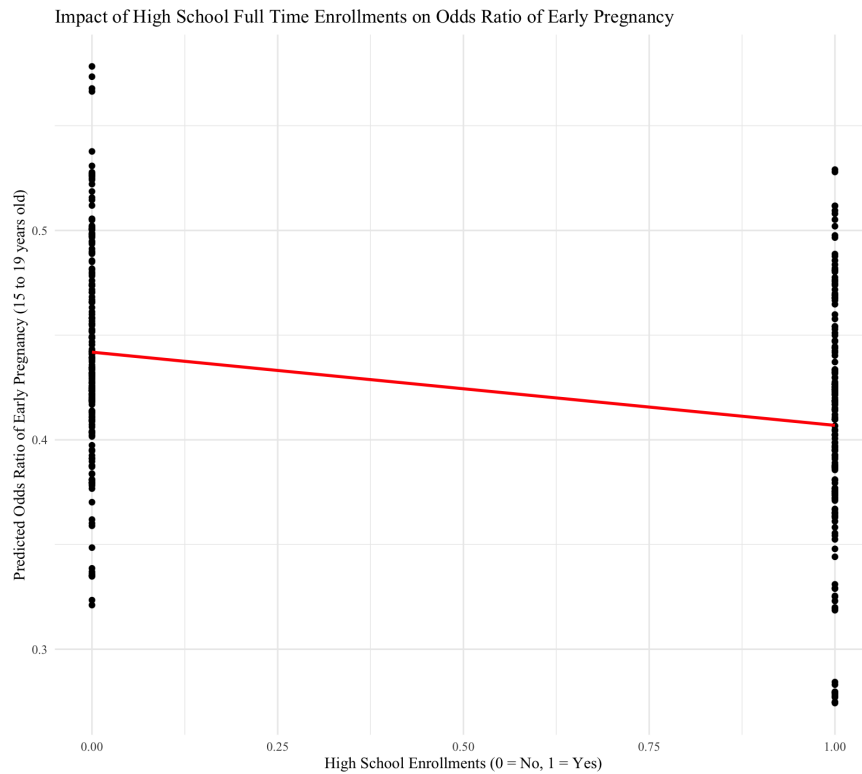
The calculated odds ratio is extremely high for the proportion of males, indicating a strong positive relationship between this variable and the log-odds of the early pregnancy rate between 15 to 19 years old. For each additional unit in the proportion of males, the odds of early childbearing can increase significantly in the municipality, and this relationship is significant at less than one 1%.

**Table 5. GLMM Model Summaries**

Predictors	2010-2015		
	Estimates	std. Error	<i>p</i>
Intercept	-4.79	1.06	<b>&lt;0.001</b>
High School Enrollments (Dummy)	-0.05	0.02	<b>0.016</b>
Log GDP per Capita	-0.03	0.03	0.421
High School Failures	-0.14	0.20	0.483
High School Dropouts	-0.01	0.22	0.968
HDI Index	0.20	0.19	0.286
Proportion of Males	7.84	1.88	<b>&lt;0.001</b>
Primary Health Care Coverage	0.01	0.04	0.830
<b>Random Effects</b>			
$\sigma^2$		-0.01	
$\tau_{00}$ (year)		0.00	
$\tau_{00}$ (municipality)		0.01	
ICC		1.83	
N (year)		6	
N (municipality)		62	
Observations		359	
Marginal $R^2$ / Conditional $R^2$		0.435 / 1.468	

The plot below provides a visual representation of the predicted values of the model. When the dummy for enrolments equals one, hence, the municipality has enrolments in high school full time, the odds of early childbearing decrease, and this relationship is significant at 5%.

**Figure 1**  
*Estimated Relationship*



Several significant limitations are evident in the tables above. First, the random variance in the model is primarily due to differences between municipalities rather than changes over the years – and the variance is relatively low. This situation rises questions around the suitability of the chosen methodology. Additionally, other anomalies in the table include the sigma squared – which theoretically should be positive – and the inflated conditional  $R^2$ . These issues can arise due to model complexity, multicollinearity, and limited sample sizes. Those limitations and future research implications will be discussed in the following section.

### Discussion

The main take away from this analysis is that, overall, amazonian municipalities with enrolments in high school full time may be indeed correlated with lower chances of early childbearing, compared to municipalities without enrolments – and this relationship is especially significant for the lower-to-medium income level group.

Hence, this study suggests that full-time education during the teenage years may play a more effective role in influencing fertility intentions and decisions compared to traditional education, thereby rejecting the initially stated null hypothesis. The preliminary analysis of this study supports these findings, as the Spearman correlation test, detailed in the appendix, also indicates a negative significant relationship between the variables.

However, the current secondary data analysis is not sufficient to clearly assert that the mechanism behind this diagnosed correlation is indeed due to a change in the adopted life strategy. It is also not possible to robustly affirm that there is a change in the perception of threats in the environment.

To identify the psychological mechanisms, a qualitative approach to research or the collection of primary data would have been better, facts which were noticed later on during the execution of this work. Yet, these results remain valuable as they suggest the empowering aspect of education as an essential tool in fostering higher levels of agency and perception of control over one's own life – especially among the less economically fortunate.

Other interesting finding of the presented work is the outcome for the high-income municipalities. In fact, all variables lose significance to explain the variance in the log-odds of early pregnancy in this group. This outcome suggests that, for this specific income level, early pregnancy among 15 to 19 years old might be explained by other factors not included in the model.

The early pregnancy rate also seemed quite sensitive towards sex ratios. The proportion of males is consistently significant across almost all models, losing significance in the high-income group. Overall, there is a strong positive association: if the proportion of men increases in the municipality, early fertility is likely to increase. Nevertheless, what is driving this outcome is not clear in this study.

Initially, the intuitive interpretation could be linked to the biological aspect: it is reasonable to assume that men can impregnate women much more easily and quickly than women can gestate. Therefore, a higher proportion of men would naturally be associated with higher

fertility rates. However, the GLMM models suggest that the proportions of men and women become unstable when municipalities are analysed by income levels. The biological interpretation should be independent of income segments, and this does not seem to be the case.

This variable was included as a proxy for sexual violence and risky sexual behaviour. The fact that it loses statistical significance as income level increases presents a scientifically interesting scenario. This positive strong association, mainly in low-medium income municipalities, may be reflecting the behaviours of a traditional society, guided by patriarchal values and characterized by misogyny and violence against women. This is a case of endogeneity that needs to be explored further in future research.

In economic literature, higher income levels are associated with higher educational levels and lower crime rates (Lochner & Moretti, 2004; Bell et al., 2018; Ziedenberg et al., 2007; Jonck et al., 2015). It could be the case that data is suggesting a shift in social norms and culture once socioeconomic opportunities improve. Nevertheless, this is mainly an insight from the model, and this study cannot robustly affirm that this is indeed the case for the Amazon region.

In fact, no variables regarding social norms, religion, and group behaviour were included in the model due to a lack of data availability, although these factors can be important drivers of fertility decisions in Brazil (Gupta, 2000; Heilborn et al., 2007; Almeida & Aquino, 2009; Cruz et al., 2021; Heilborn & Cabral, 2011; Aizen & Klobas, 2013). To collect data on Brazilian social norms, especially in Amazon, could be an interesting extension of the current study.

Nevertheless, this research faced several limitations. The sample size is quite small, and the data is mainly non-parametric and heteroscedastic, with outliers<sup>6</sup>. This behaviour is expected given the high levels of social inequality in Amazon<sup>7</sup>. The sample is limited because Brazil's production of data at the municipality level is scarce, making it very difficult to obtain all the information for each municipality in each year for a specific state. Hence, working with this

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<sup>6</sup> To remove outliers was not an option. The sample size got extremely small and the GLMM models performed better with outliers, which means that the outliers in the sample are indeed important to explain the relationship in question.

<sup>7</sup> Some municipalities can experience a very high level of GDP, far away from the mean. Other illustrative cases are the poorer municipalities, more likely of reporting very high failure and dropout rates in high school, making data highly skewed and abnormal.

dataset was very challenging and, unfortunately, accessing alternative data on this specific issue for Brazil is not a trivial task.

An attempt to address the specific behaviour of the data was to divide the dataset into subsamples by income levels, grouping municipalities that could be more homogeneous. However, even when splitting into three groups, the income range may still be inefficient, as it combines municipalities that remain heterogeneous. This research thus highlights the real challenges of conducting reliable research in very unequal countries. Dividing the already small main sample into more subsamples would further reduce the sample size, exacerbating these challenges.

The small sample size can also explain the instability detected in the sigma squared indicator. A six-year panel may be too short to detect substantial variability in the teenage pregnancy rate throughout the years and between municipalities. Hence, it might be a challenge to accurately estimate variance indicators, making the model less efficient – though not necessarily biased.

Inherent characteristics of the country may also contribute to the low variance of the sample. Political cycles characterized by corruption can prevent significant changes in power, hindering meaningful social transformations (Pohlmann & Valarini, 2020). Therefore, six years might be too short to detect any significant changes in socioeconomic life, considering this context.

To provide a robustness test and achieve more stable estimates, a Bayesian regression for the global model is included in the appendix. The only variable that is strongly significant is the proportion of males (CI 95%: 3.69, 11.45). The dummy variable for enrolments showed a weak and marginally negative association. Although statistically significant, its confidence interval nearly included zero (CI 95%: -0.09, -0.01). The Bayesian approach, which is suitable for small samples, was also unable to calculate the sigma squared, further indicating the low variance detected in the collected sample.

One could argue that the main issue is due to model complexities and multicollinearity –

hence why it retrieves an inflated conditional  $R^2$ . A multicollinearity test was conducted using the Variance Inflation Factor (VIF) before running all models, and no serious multicollinearity problems were detected. Regarding model complexity, the removal of insignificant variables did not change the outcome – the sigma squared is still negative and the conditional  $R^2$  is still inflated.

To better assess model complexity, an analysis comparing a simple Beta Regression with the GLMM methodology was performed<sup>8</sup>. The conclusion is that, although the variability between years and municipalities is low, it remains significant in explaining the early pregnancy rate in Amazon. Using the Akaike Information Criterion (AIC) (Burnham & Anderson, 2002) for model selection, the GLMM was determined to be a better and more accurate methodology. Yet, the possibility of overfitting cannot be ruled out. A residual analysis, available in the appendix, shows that the models are well-fitted, with insignificant deviations.

The overfitting hypothesis can also explain the extreme sensitivity towards the sex odds ratio. In other words, the GLMM model may actually be modelling the noise in the data instead of the real relationship – and this behaviour could also be due to omitted variable bias. Additionally, when facing overfitting issues, the external validity of the research becomes questionable. Hence, the results stated here might only be applicable to the context of the created sample, with limited generalisability.

To conclude the discussion section of this work, two important points need to be addressed. First, the distorted result of the dropout rate for middle-income municipalities. If the proportion of males is indeed very significant in explaining the variance in the log-odds of early pregnancy, the negative sign of the dropout rate could be due to selection bias.

In the specific context of Amazon, there is data showing that men drop out of school more frequently than women to join the labour force prematurely<sup>9</sup>, which could lead to this strange

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<sup>8</sup> To see the results for multicollinearity and the Global Beta Regression versus GLMM estimators, see the appendix below.

<sup>9</sup> CIEAM. (2022, April 5). In the Amazon, women are more educated than men, but suffer from unemployment. <https://cieam.com.br/noticias/na-amazonia-mulheres-sao-mais-escolarizadas-que-homens-mas-sofrem-com-desemprego>

negative relationship between dropping out and decreasing early pregnancy<sup>10</sup>. However, the study developed here does not have enough information to state definitively that this is the case. It is safer to assume that this problem is likely due to omitted variable bias, which could be better investigated in further research.

Finally, the Amazon region also faces serious issues with age-grade distortion. Therefore, the early pregnancy rate used in this study, among those aged 15 to 19, does not necessarily reflect the age at which young girls attend high school – many of them are likely to be behind in their studies. Addressing this issue is an important factor for future research as well.

### Conclusion

This work faced a series of challenges in data collection to perform the proposed analysis. It somewhat demonstrated what it set out to: full-time education during adolescence may be the most suitable pedagogical model to prevent early pregnancy. However, the challenges with modelling and the extremely limited dataset do not allow us to assert that this will be the general case for the Amazon region, across locations and time periods. More detailed data and causal estimation methodologies are necessary to provide greater robustness to the relationship in question.

### Appendix

#### Descriptive statistics

The table below summarizes the descriptive statistics of the dependent variable. The information provided describes a fairly symmetrical variable, slightly leptokurtic and positively skewed. Hence, its distribution has a heavier right tail and a more pronounced peak than a normal distribution – which signals extreme values or outliers.

**Table 6. Descriptive statistics (Early Pregnancy between 15 to 19 years old)**

Variable	Mean	Standard Deviation	Median	Min	Max	Skew	Kurtosis	First quartile	Third quartile
Early pregnancy (15 to 19 years old)	0.3	0.04	0.3	0.19	0.43	0.15	0.36	0.27	0.32

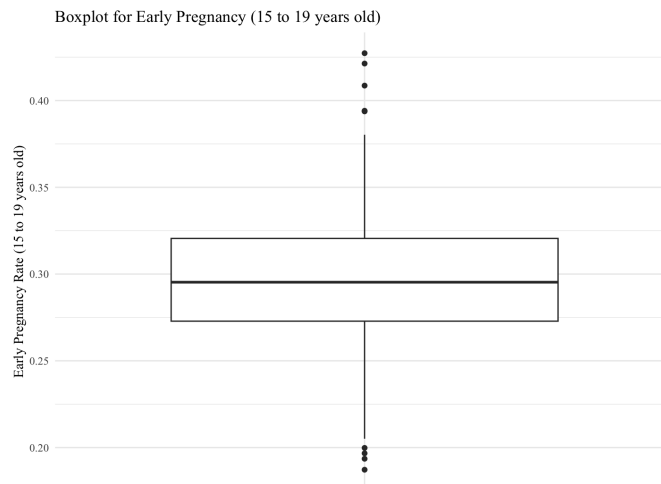
<sup>10</sup> The insight presented here is that perhaps the population most strongly correlated with early pregnancy is also selecting itself out of schools - men who drop out of high school to work.



To better understand the existence of outliers, a boxplot of the data was created in R. The image below shows the results. Outliers were detected. However, they were not removed due to sample limitations and also to avoid loss of valuable information to explain the relationship in question.

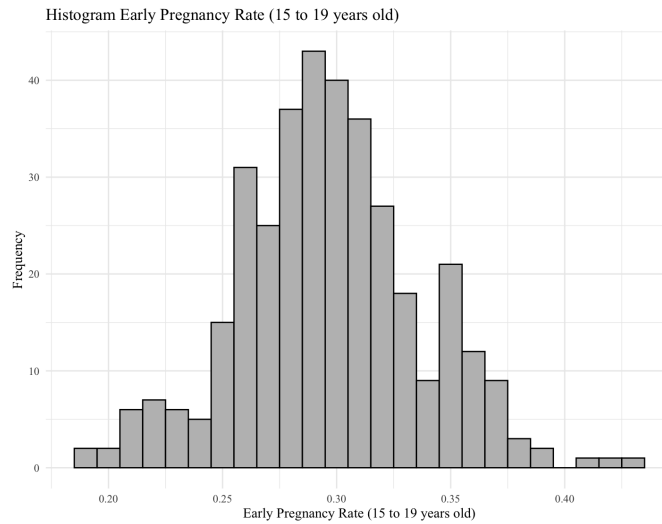
## Figure 2

*Boxplot of the dependent variable*



A histogram of the dependent variable is also provided below. The data visualization reveals, at first, a reasonable normal distribution. However, once performing the Shapiro-Wilk test for normality, the p-value is lower than 0.05 (0.0375). Hence, the null hypothesis was rejected and there is evidence to suggest that the early pregnancy rate is not normally distributed. In this way, the data presented here supported the choice of a more flexible methodology that could accommodate non-normal variables, such as the Generalized Linear Mixed Model (GLMM).

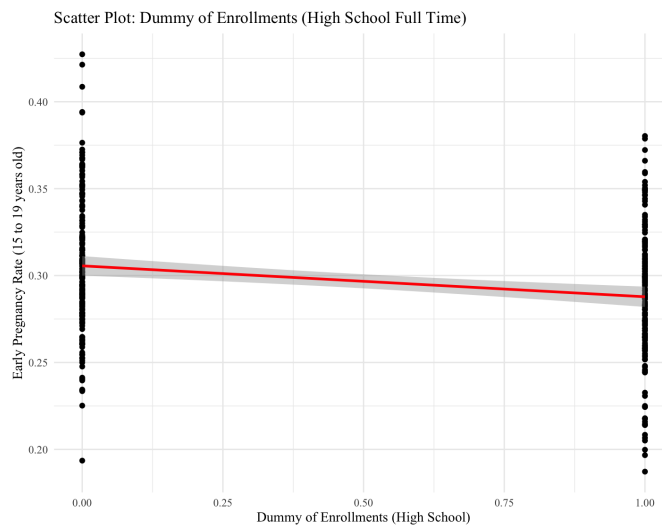
**Figure 3**  
*Histogram of the dependent variable*



**Preliminary analysis**

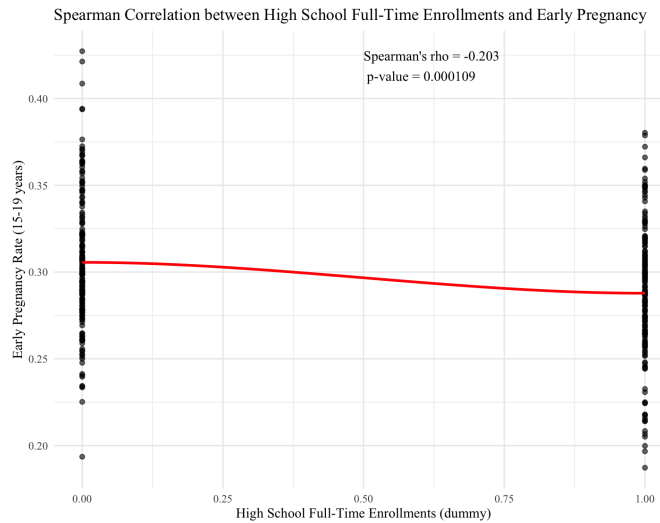
The Scatter Plot graph below highlights the preliminary analysis for the relationship in question. There is a slightly negative fitted line in the plot, which suggests that once the dummy for enrollments in high school full time equals to one for the respective municipality, the early pregnancy rate is likely to decline.

**Figure 4**  
*Scatter plot of the estimated linear relationship*



The Spearman's coefficient and correlation test were also performed in R for a first insightful analysis. The coefficient was negative (-0.203), and the p-value of the test was very low (0.000109). The null hypothesis was successfully rejected, hence, there is evidence of a negative correlation between variables, even though the association is weak.

**Figure 5**  
*Spearman Correlation*



**Models with the proportion of females****Table 7. GLMM Model Summaries for Low to Medium Income Municipalities (Females)**

Predictors	Low Income			Medium Income		
	Estimates	std. Error	<i>p</i>	Estimates	std. Error	<i>p</i>
Intercept	2.95	1.76	0.095	2.05	1.96	0.295
High School Enrollments (Dummy)	-0.08	0.04	<b>0.031</b>	-0.07	0.03	<b>0.032</b>
Log GDP per Capita	0.13	0.10	0.189	0.15	0.18	0.399
High School Failures	0.00	0.38	0.993	-0.23	0.30	0.442
High School Dropouts	0.27	0.39	0.482	-0.88	0.39	<b>0.026</b>
HDI Index	0.22	0.32	0.494	0.39	0.32	0.219
Proportion of Females	-10.45	3.17	<b>0.001</b>	-8.83	2.65	<b>0.001</b>
Primary Health Care Coverage	0.02	0.07	0.709	-0.07	0.08	0.437
<b>Random Effects</b>						
$\sigma^2$		-0.01			-0.01	
$\tau_{00}$ (year)		0.00			0.00	
ICC		0.02 (municipality)			0.01 (municipality)	
N (year)		6			6	
Observations		45 (municipality)			49 (municipality)	
Marginal $R^2$ / Conditional $R^2$		118			119	
		0.400 / 1.219			0.839 / 1.920	

**Table 8. GLMM Model Summaries for High Income Municipalities (Females)**

Predictors	High Income		
	Estimates	Std. Error	<i>p</i>
Intercept	2.21	1.41	0.117
High School Enrollments (Dummy)	-0.02	0.03	0.423
Log GDP per Capita	-0.03	0.05	0.602
High School Failures	-0.34	0.38	0.364
High School Dropouts	-0.26	0.35	0.448
HDI Index	-0.16	0.27	0.548
Proportion of Females	-5.60	3.08	0.069
Primary Health Care Coverage	-0.01	0.09	0.907
<b>Random Effects</b>			
$\sigma^2$		-0.00	
$\tau_{00}$ (year)		0.00	
$\tau_{00}$ (municipality)		0.01	
ICC		1.44	
N (year)		6	
N (municipality)		30	
Observations		122	
Marginal $R^2$ / Conditional $R^2$		0.362 / 1.280	

**Table 9. GLMM Global Model Summaries (Females)**

Predictors	Amazonian Municipalities (2010-2015)		
	Estimates	Std. Error	<i>p</i>
Intercept	3.51	0.97	<b>&lt;0.001</b>
High School Enrollments (Dummy)	-0.04	0.02	<b>0.025</b>
Log GDP per Capita	-0.03	0.03	0.397
High School Failures	-0.11	0.20	0.566
High School Dropouts	0.00	0.22	0.990
HDI Index	0.19	0.18	0.299
Proportion of Females	-8.78	2.05	<b>&lt;0.001</b>
Primary Health Care Coverage	0.01	0.04	0.835
<b>Random Effects</b>			
$\sigma^2$		-0.01	
$\tau_{00}$ (year)		0.00	
$\tau_{00}$ (municipality)		0.01	
ICC		1.80	
N (year)		6	
N (municipality)		62	
Observations		359	
Marginal $R^2$ / Conditional $R^2$		0.454 / 1.437	

**GLMM Global Model Summaries with a Bayesian Approach****Table 10. Bayesian Approach vs GLMM Estimates (2010-2015)**

Predictors	Bayesian Approach		GLMM Estimates		
	Estimates	Std. Error	Estimates	Std. Error	<i>p</i>
Intercept	-4.59	1.14	-4.79	1.06	<b>&lt;0.001</b>
High School Enrollments (Dummy)	-0.05	0.02	-0.05	0.02	<b>0.016</b>
Log GDP per Capita	-0.03	0.03	-0.03	0.03	0.421
High School Failures	-0.14	0.22	-0.14	0.20	0.483
High School Dropouts	-0.03	0.24	-0.01	0.22	0.968
HDI Index	0.19	0.20	0.20	0.19	0.286
Proportion of Males	7.54	2.00	7.84	1.88	<b>&lt;0.001</b>
Primary Health Care Coverage	0.01	0.05	0.01	0.04	0.830
<b>Random Effects</b>					
$\sigma^2$		NaN		-0.01	
$\tau_{00}$ (municipality)		0.02		0.00 (year)	
$\tau_{00}$ (year)		0.00		0.01 (municipality)	
ICC				1.83	
N (year)		6		6	
N (municipality)		62		62	
Observations		359		359	
Marginal $R^2$ / Conditional $R^2$		0.179 / 0.570		0.435 / 1.468	

**Multicollinearity test**

As showed by the table below, the Variance Inflation Factor for all variables are under 10, indicating that they are not correlated with each other.

**Table 11. Multicollinearity Test table**

Variable	Variance Inflation Factor (VIF)
Enrolments in High School full time	1.063
Dropout rate (High School)	1.153
Primary health care coverage	1.192
GDP per capita (log)	1.551
Human Development Index	1.717
Failure rate (High School)	1.136
Proportion of Males	1.290

**Beta Regression versus GLMM****Table 12. Beta Regression vs GLMM model Summaries (2010-2015)**

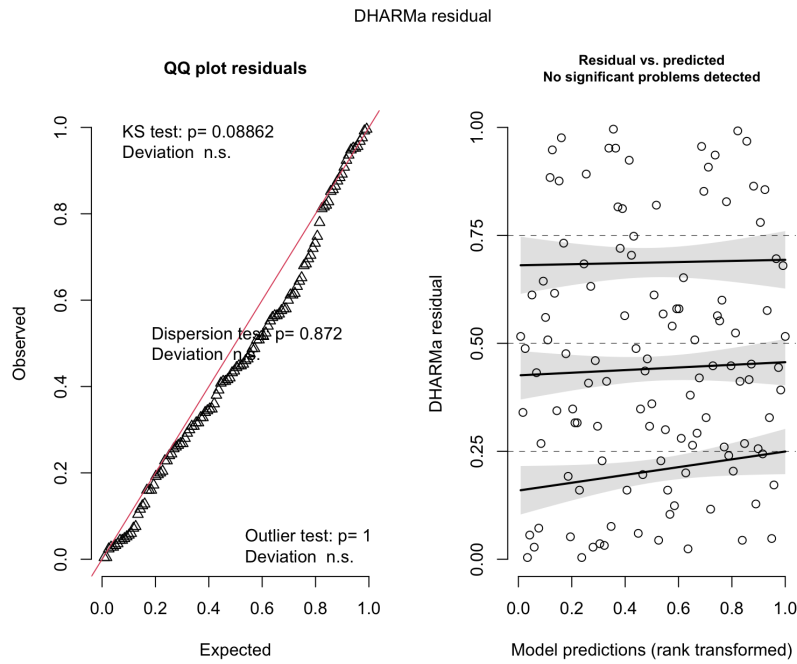
Predictors	Beta Regression			GLMM Model		
	Estimates	Std. Error	<i>p</i>	Estimates	Std. Error	<i>p</i>
Intercept	-6.05	0.36	<b>&lt;0.001</b>	-4.79	1.06	<b>&lt;0.001</b>
High School Enrollments (Dummy)	-0.03	0.01	<b>0.003</b>	-0.05	0.02	<b>0.016</b>
Log GDP per Capita	0.02	0.01	<b>0.016</b>	-0.03	0.03	0.421
High School Failures	-0.25	0.12	<b>0.031</b>	-0.14	0.20	0.483
High School Dropouts	-0.55	0.12	<b>&lt;0.001</b>	-0.01	0.22	0.968
HDI Index	-0.15	0.08	0.072	0.20	0.19	0.286
Proportion of Males	9.79	0.64	<b>&lt;0.001</b>	7.84	1.88	<b>&lt;0.001</b>
Primary Health Care Coverage	0.01	0.02	0.593	0.01	0.04	0.830
<b>Random Effects</b>						
$\sigma^2$					-0.01	
$\tau_{00}$ (year)					0.00	
$\tau_{00}$ (municipality)					0.01	
ICC					1.83	
N (year)		6			6	
N (municipality)		62			62	
Observations		359			359	
Marginal $R^2$ / Conditional $R^2$		0.196			0.435 / 1.468	



**Residual Analysis**

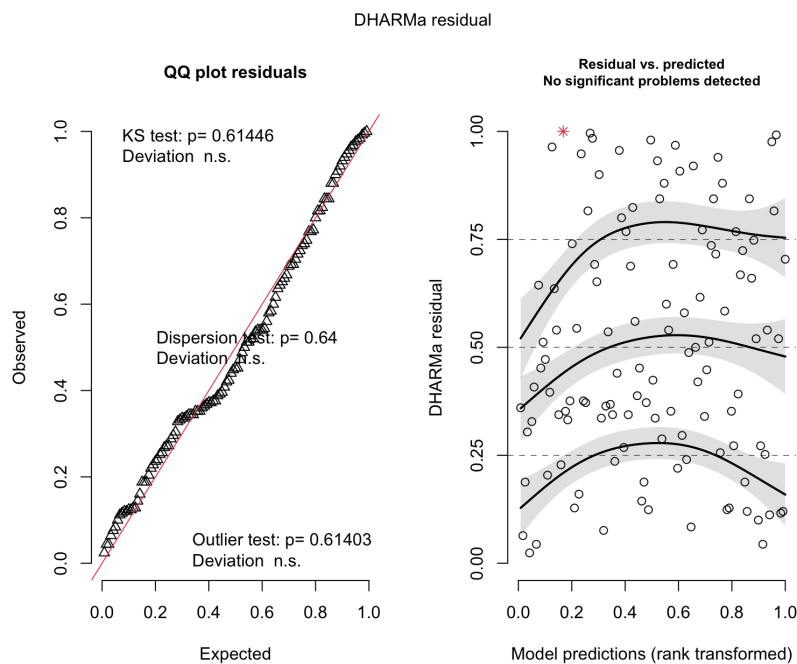
**Figure 6**

*Residual Analysis: Low-Income Municipalities*

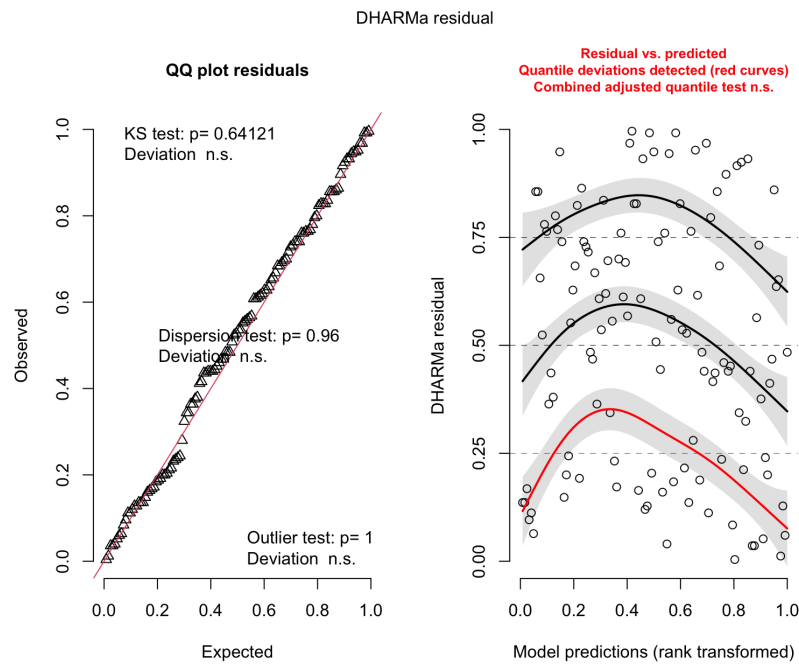


**Figure 7**

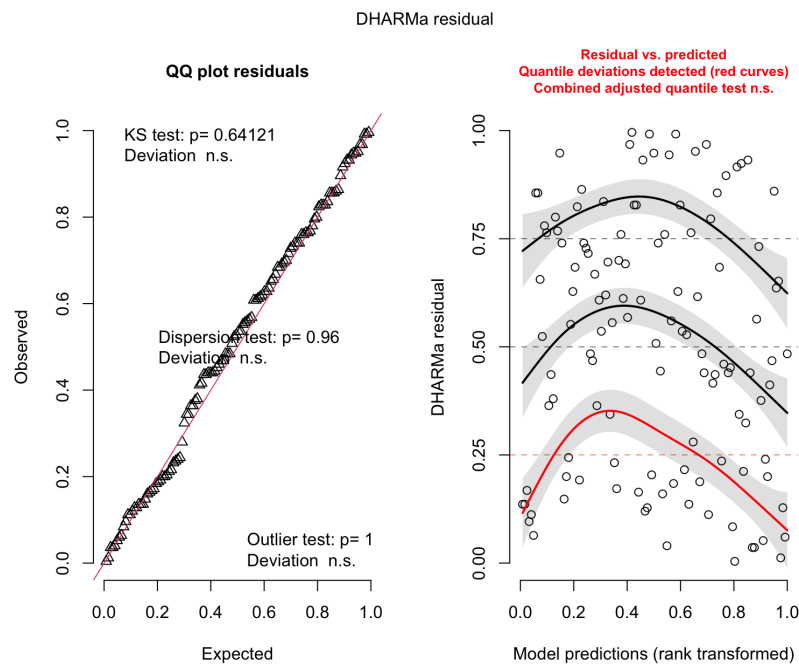
*Residual Analysis: Medium-Income Municipalities*



**Figure 8**  
*Residual Analysis: High-Income Municipalities*



**Figure 9**  
*Residual Analysis: Global Model*



### References

- Abera, M., Nega, A., Tefera, Y., & Gelagay, A. A. (2020). Early marriage and women's empowerment: The case of child-brides in Amhara National Regional State, Ethiopia. *BMC International Health and Human Rights*, 20(1). <https://doi.org/10.1186/s12914-020-00249-5>
- Achen, S., Atekyereza, P., & Rwabukwali, C. B. (2021). The role of culture in influencing sexual and reproductive health of pastoral adolescent girls in Karamoja sub-region in Uganda. *Pastoralism*, 11(1). <https://doi.org/10.1186/s13570-020-00188-9>
- Aizen, I., & Klobas, J. (2013). Fertility intentions. *Demographic Research*, 29, 203–232. <https://doi.org/10.4054/demres.2013.29.8>
- Ajayi, A. I., & Ezegbe, H. C. (2020). Association between sexual violence and unintended pregnancy among adolescent girls and young women in South Africa. *BMC Public Health*, 20(1). <https://doi.org/10.1186/s12889-020-09488-6>
- Akram, S., & Pervaiz, Z. (2020). Mother's education as a predictor of individual's opportunities to learn and earn. *Ilkogretim Online - Elementary Education Online*, 19(4), 879–884.
- Almeida, M. da C. C. de, & Aquino, E. M. L. (2009). The role of education level in the intergenerational pattern of adolescent pregnancy in Brazil. *International Perspectives on Sexual and Reproductive Health*, 35(3), 139–146. <https://doi.org/10.1363/3513909>
- Alzúa, M. L., & Velázquez, C. (2017). The effect of education on teenage fertility: Causal evidence for Argentina. *IZA Journal of Development and Migration*, 7(1). <https://doi.org/10.1186/s40176-017-0100-8>
- Pourtaheri, A., Mahdizadeh, M., Tehrani, H., Jamali, J., & Peyman, N. (2024). Socio-ecological factors of girl child marriage: A meta-synthesis of qualitative research. *BMC Public Health*, 24(1). <https://doi.org/10.1186/s12889-023-17626-z>
- Ayalew, H. G., Liyew, A. M., Tessema, Z. T., Worku, M. G., Tesema, G. A., Alamneh, T. S., Teshale, A. B., Yeshaw, Y., & Alem, A. Z. (2022). Prevalence and factors associated with unintended

pregnancy among adolescent girls and young women in sub-Saharan Africa, a multilevel analysis. *BMC Women's Health*, 22(1), 464. <https://doi.org/10.1186/s12905-022-02048-7>

Azevedo, J. P., Lopez-Calva, L. F., & Perova, E. (2012). Is the baby to blame? An inquiry into the consequences of early childbearing. *Policy Research Working Paper*, 6074. World Bank, Washington, DC.

Balarín, M., Alcázar, L., Rodríguez, M. F., & Glave, C. (2017). Transiciones inciertas: Una mirada a los jóvenes de contextos urbanos vulnerables de Lima. *Documentos de Investigación*, 84. GRADE, Lima.

Barber, N. (2014). The sex ratio as a predictor of cross-national variation in violent crime.

*Cross-Cultural Research*, 48(4), 267–290. [https://www.researchgate.net/publication/272951624\\_The\\_Sex\\_Ratio\\_as\\_a\\_Predictor\\_of\\_Cross-National\\_Variation\\_in\\_Violent\\_Crime](https://www.researchgate.net/publication/272951624_The_Sex_Ratio_as_a_Predictor_of_Cross-National_Variation_in_Violent_Crime)

Becker, G. (1960). An economic analysis of fertility. National Bureau of Economic Research, New York, NY. <https://www.nber.org/system/files/chapters/c2387/c2387.pdf>

Becker, G. (1991). A treatise on the family. Harvard University Press, Cambridge, MA.

Becker, G. S., & Lewis, H. G. (1973). On the interaction between the quantity and quality of children.

*Journal of Political Economy*, 81(2, Part 2), S279–S288. <https://doi.org/10.1086/260166>

Bell, B., Costa, R., & Machin, S. J. (2018). Why does education reduce crime? *SSRN Electronic Journal*.

<https://doi.org/10.2139/ssrn.3253463>

Belsky, J. (2012a). The development of human reproductive strategies: Progress and prospects. *Current*

*Directions in Psychological Science*, 21(5), 310–316. <https://doi.org/10.1177/0963721412453588>

Belsky, J., Schlomer, G. L., & Ellis, B. J. (2012b). Beyond cumulative risk: Distinguishing harshness and unpredictability as determinants of parenting and early life history strategy. *Developmental*

*Psychology*, 48(3), 662–673. <https://doi.org/10.1037/a0024454>

Benevides, A. de A., Sousa, A. O., de Sousa, D. T., & Mariano, F. Z. (2024). Does extending school time reduce the juvenile pregnancy rate? A longitudinal analysis of Ceará State (Brazil). *Economia*,

ahead-of-print. <https://doi.org/10.1108/ECON-11-2023-0192>

Berthelon, M. E., & Kruger, D. I. (2011). Risky behavior among youth: Incapacitation effects of school on adolescent motherhood and crime in Chile. *Journal of Public Economics*, 95(1-2), 41–53.

<https://doi.org/10.1016/j.jpubeco.2010.09.004>

Blanchard, B. E., & Centifanti, L. C. M. (2020). Crime frequency and chronicity in youth: Examining differences in sex and externalizing behaviors. *Journal of Research in Personality*, 88, 103980.

<https://doi.org/10.1016/j.jrp.2020.103980>

Briones, K., & Porter, C. (2019). How does teenage marriage and motherhood affect the lives of young women in Ethiopia, India, Peru and Vietnam? *Young Lives*.

[https://www.younglives.org.uk/sites/default/files/2022-12/YL-WP186-Proof04\\_0.pdf](https://www.younglives.org.uk/sites/default/files/2022-12/YL-WP186-Proof04_0.pdf)

Burnham, K. P., & Anderson, D. R. (2002). *Model selection and multimodel inference: A practical information-theoretic approach*. Springer Science & Business Media.

CIEAM. (2022, April 5). In the Amazon, women are more educated than men, but suffer from unemployment. *CIEAM*. <https://cieam.com.br/noticias/>

[na-amazonia-mulheres-sao-mais-escolarizadas-que-homens-mas-sofrem-com-desemprego](https://cieam.com.br/noticias/na-amazonia-mulheres-sao-mais-escolarizadas-que-homens-mas-sofrem-com-desemprego)

Cruz, E., Cozman, F. G., Souza, W., & Takiuti, A. (2021). The impact of teenage pregnancy on school dropout in Brazil: A Bayesian network approach. *BMC Public Health*, 21(1).

Diamond-Smith, N., & Rudolph, K. (2018). The association between uneven sex ratios and violence: Evidence from 6 Asian countries. *PLOS ONE*, 13(6), e0197516.

<https://doi.org/10.1371/journal.pone.0197516>

Dos Santos, T. C. M., Da Silva, T. R. R., Porfirio, B. K. A., Da Silva, A. do S., & De Brito, S. R. (2021). Gravidez na adolescência e indicadores de desenvolvimento: Análise baseada em mineração de dados. *Brazilian Journal of Development*, 7(9), 88488–88504.

<https://doi.org/10.34117/bjdv7n9-149>

Early pregnancy in Northern Brazil has a rate comparable to that of sub-Saharan Africa. (2024, March

28). *Folha de S. Paulo*. [https://www1.folha.uol.com.br/equilibrioesaude/2024/03/gravidez-precoce-no-norte-do-brasil-tem-indice-comparavel-ao-da-africa-subsaariana.shtml?utm\\_source=whatsapp&utm\\_medium=social&utm\\_campaign=compwa](https://www1.folha.uol.com.br/equilibrioesaude/2024/03/gravidez-precoce-no-norte-do-brasil-tem-indice-comparavel-ao-da-africa-subsaariana.shtml?utm_source=whatsapp&utm_medium=social&utm_campaign=compwa)

Eggleston, E., Jackson, J., Rountree, W., & Pan, Z. (2000). Evaluation of a sexuality education program for young adolescents in Jamaica. *Revista Panamericana de Salud Pública*, 7(2), 102–112. <https://doi.org/10.1590/s1020-49892000000200006>

Ellis, B. J., Figueredo, A. J., Brumbach, B. H., & Schlomer, G. L. (2009). Fundamental dimensions of environmental risk. *Human Nature*, 20(2), 204–268. <https://doi.org/10.1007/s12110-009-9063-7>

Ferrari, S., & Cribari-Neto, F. (2004). Beta regression for modelling rates and proportions. *Journal of Applied Statistics*, 31(7), 799–815. [https://econpapers.repec.org/article/tafjapsta/v\\_3a31\\_3ay\\_3a2004\\_3ai\\_3a7\\_3ap\\_3a799-815.htm](https://econpapers.repec.org/article/tafjapsta/v_3a31_3ay_3a2004_3ai_3a7_3ap_3a799-815.htm)

Figueredo, A. J., Vásquez, G., Brumbach, B. H., & Schneider, S. M. R. (2004). The heritability of life history strategy: The K-factor, covitality, and personality. *Biodemography and Social Biology*, 51(2), 121–143.

Franco, A. P., & Ñopo, H. (2018). *Ser joven en el Perú: Educación y trabajo*. GRADE.

Globo. (2023, July 30). More than 70% of cases of violence against minors in AM are recorded among female victims. *GI*. <https://g1.globo.com/am/amazonas/noticia/2023/07/30/mais-de-70percent-dos-casos-de-violencia-contra-menores-no-am-sao-registrados-em-vitimas-do-sexo-feminino-ghtml>

Globo. (2024, March 18). 7 out of 10 victims of violence against women in the Legal Amazon are up to 14 years old, according to research. *GI*. <https://g1.globo.com/meio-ambiente/noticia/2024/03/18/7-em-cada-10-vitimas-de-violencia-contra-mulher-na-amazonia-legal-tem-ate-14-anos-aponta-pesquisa-ghtml>

Gupta, N. (2000). Sexual initiation and contraceptive use among adolescent's woman in northeastern Brazil. *Studies in Family Planning*, 31, 228–238.

- Gutiérrez Vázquez, E. Y., & Parrado, E. A. (2016). Abortion legalization and childbearing in Mexico. *Studies in Family Planning*, 47(2), 113–128. <https://doi.org/10.1111/j.1728-4465.2016.00060.x>
- Heilborn, M. L., & Cabral, C. S. (2011). A new look at teenage pregnancy in Brazil. *ISRN Obstetrics and Gynecology*, 1–7. <https://doi.org/10.5402/2011/975234>
- Heilborn, M. L., Brandão, E. R., & Cabral, C. D. S. (2007). Teenage pregnancy and moral panic in Brazil. *Culture, Health & Sexuality*, 9(4), 403–414. <https://doi.org/10.1080/13691050701369441>
- Hunger, M., Döring, A., & Holle, R. (2012). Longitudinal beta regression models for analyzing health-related quality of life scores over time. *BMC Medical Research Methodology*, 12(1), 144. <https://doi.org/10.1186/1471-2288-12-144>
- Imamura, M., Tucker, J., Hannaford, P., da Silva, M. O., Astin, M., Wyness, L., Bloemenkamp, K. W. M., Jahn, A., Karro, H., Olsen, J., & Temmerman, M. (2007). Factors associated with teenage pregnancy in the European Union countries: A systematic review. *The European Journal of Public Health*, 17(6), 630–636. <https://doi.org/10.1093/eurpub/ckm014>
- Tukey, J. W. (1977). *Exploratory data analysis*. Addison-Wesley Publishing Company.
- Jonck, P., Goujon, A., Testa, M. R., & Kandala, J. (2015). Education and crime engagement in South Africa: A national and provincial perspective. *International Journal of Educational Development*, 45, 141–151. <https://doi.org/10.1016/j.ijedudev.2015.10.002>
- Jones, L. E., & Tertilt, M. (2009). An economic history of fertility in the United States: 1826–1960. *Frontiers of Family Economics*, 165–230. [https://doi.org/10.1016/s1574-0129\(08\)00005-7](https://doi.org/10.1016/s1574-0129(08)00005-7)
- Kågesten, A., Gibbs, S., Blum, R. W., Moreau, C., Chandra-Mouli, V., Herbert, A., & Amin, A. (2016). Understanding factors that shape gender attitudes in early adolescence globally: A mixed-methods systematic review. *PLOS ONE*, 11(6), e0157805. <https://doi.org/10.1371/journal.pone.0157805>
- Kaplan, H. S., & Gangestad, S. W. (2005). Life history theory and evolutionary psychology. In D. M. Buss (Ed.), *Handbook of evolutionary psychology* (pp. 68–95). Wiley.

- Kay, A. C., Whitson, J. A., Gaucher, D., & Galinsky, A. D. (2009). Compensatory control: Achieving order through the mind, our institutions, and the heavens. *Current Directions in Psychological Science*, 18, 264–268. <https://doi.org/10.1111/j.1467-8721.2009.01649.x>
- Khalid, A. (2023). Mothers and their daughters' education: A comparison of global and local aspirations. *Comparative Education*, 1–23. <https://doi.org/10.1080/03050068.2023.2186656>
- King, E. M., & Hill, M. A. (1993). *Women's education in developing countries: Barriers, benefits, and policies*. World Bank Publications.
- Kolk, M. (2022). The relationship between life-course accumulated income and childbearing of Swedish men and women born 1940–70. *Population Studies*, 1–19. <https://doi.org/10.1080/00324728.2022.2134578>
- Lochner, L., & Moretti, E. (2004). The effect of education on crime: Evidence from prison inmates, arrests, and self-reports. *The American Economic Review*, 94(1), 155–189. <https://www.jstor.org/stable/3592774>
- Maia, A. C., & Barreto, M. (2012). Violência contra crianças e adolescentes no Amazonas: Análise dos registros. *Psicologia Em Estudo*, 17, 195–204. <https://www.scielo.br/j/pe/a/BDtz6Sb5hCbJdz7tT5CCHH/>
- Mello, M., & Buccione, G. (2023, July 5). Religious media, conversion, and the socioeconomic consequences. *Personal Website*. <https://marcelamello90.github.io/Paper/JMP.pdf>
- Mittal, C., & Griskevicius, V. (2014). Sense of control under uncertainty depends on people's childhood environment: A life history theory approach. *Journal of Personality and Social Psychology*, 107(4), 621–637. <https://doi.org/10.1037/a0037398>
- Nascimento, T. L. C., Teixeira, C. S. S., Anjos, M. S. dos, Menezes, G. M. de S., Costa, M. da C. N., & Natividade, M. S. da (2021). Fatores associados à variação espacial da gravidez na adolescência no Brasil, 2014: Estudo ecológico de agregados espaciais. *Epidemiologia E Serviços de Saúde*, 30(1). <https://doi.org/10.1590/s1679-49742021000100003>



- Nettle, D. (2010). Dying young and living fast: Variation in life history across English neighborhoods. *Behavioral Ecology*, 21(2), 387–395. <https://doi.org/10.1093/beheco/arp202>
- Nettle, D., Coall, D. A., & Dickins, T. E. (2011). Early-life conditions and age at first pregnancy in British women. *Proceedings of the Royal Society B: Biological Sciences*, 278(1712), 1721–1727. <https://doi.org/10.1098/rspb.2010.1825>
- Pabst, J., Walfield, S. M., & Schacht, R. (2022). Patterning of sexual violence against women across US cities and counties. *Social Sciences*, 11(5), 208. <https://doi.org/10.3390/socsci11050208>
- Palacios-Perdomo, H., & Acosta-Ramírez, N. (2021). Perceptions of adolescent pregnancy in the rural context and the Colombian armed conflict: A qualitative approach based on social determination of health. *International Journal for Equity in Health*, 20(1). <https://doi.org/10.1186/s12939-021-01568-2>
- Pedroso, A. O. (2022). Epidemia do HIV e os determinantes sociais em saúde entre jovens no contexto amazônico: Análise geograficamente ponderada e projeções temporais. *Master's dissertation*, Universidade Federal do Pará. UFPA Institutional Repository. <http://repositorio.ufpa.br/jspui/handle/2011/15307>
- Brazilian Hospital Services Company. (n.d.). Per hour, 44 babies are born to teenage mothers in Brazil, according to data from SUS. <https://www.gov.br/ebserh/pt-br/comunicacao/noticias/por-hora-nascem-44-bebes-de-maes-adolescentes-no-brasil-segundo-dados-do-sus>
- Peres, S. (2024, March 28). The number of women becoming mothers after 40 is increasing. *Poder360*. <https://www.poder360.com.br/brasil/cresce-numero-de-mulheres-que-se-tornam-maes-com-mais-de-40-anos/>
- Pohlmann, M., & Valarini, E. (2020). The fight against corruption in Brazil: A case of good governance? *Knowledge for Governance*, 15, 225–241. [https://doi.org/10.1007/978-3-030-47150-7\\_10](https://doi.org/10.1007/978-3-030-47150-7_10)
- Psacharopoulos, G., & Patrinos, H. A. (2018). Returns to investment in education: A decennial review of the global literature. *Education Economics*, 26(5), 445–458. <https://doi.org/10.1080/09645292.2018.1484426>

- Quinlan, R. J. (2010). Extrinsic mortality effects on reproductive strategies in a Caribbean community. *Human Nature*, 21(2), 124–139. <https://doi.org/10.1007/s12110-010-9085-1>
- Salas-Rodríguez, J., Gómez-Jacinto, L., Hombrados-Mendieta, I., & del Pino-Brunet, N. (2022). Too many males or too many females? Classroom sex ratio, life history strategies and risk-taking behaviors. *Journal of Youth and Adolescence*. <https://doi.org/10.1007/s10964-022-01635-z>
- Sánchez, A. (2019). Relación entre embarazo adolescente y maternidad adolescente y resultados educativos y laborales: Una aproximación a partir de datos de la ENDES. *Repositorios Institucional - GRADE*. <https://repositorio.grade.org.pe/handle/20.500.12820/618>
- Sánchez, A., & Favara, M. (2018). La transición hacia el mercado laboral y los estudios postsecundarios en Perú: Evidencia del estudio Niños del Milenio. *Repositorios Institucional - GRADE*. <https://repositorio.grade.org.pe/handle/20.500.12820/602>
- Sánchez, A., & Favara, M. (2019). Consequences of teenage childbearing in Peru is the extended school-day reform an effective policy instrument to prevent teenage pregnancy? *Young Lives*. <https://www.younglives.org.uk/sites/default/files/migrated/YL-WP185.pdf>
- Sarder, A., Islam, S. M. S., Maniruzzaman, & Talukder, A., & Ahammed, B. (2021). Prevalence of unintended pregnancy and its associated factors: Evidence from six south Asian countries. *PLOS ONE*, 16(2), e0245923. <https://doi.org/10.1371/journal.pone.0245923>
- Simpson, J. A., Griskevicius, V., Kuo, S. I.-C., Sung, S., & Collins, W. A. (2012). Evolution, stress, and sensitive periods: The influence of unpredictability in early versus late childhood on sex and risky behavior. *Developmental Psychology*, 48(3), 674–686. <https://doi.org/10.1037/a0027293>
- Skirbekk, V. (2008). Fertility trends by social status. *Demographic Research*, 18, 145–180. <https://doi.org/10.4054/demres.2008.18.5>
- Souza, M. M. C. (1998). A maternidade nas mulheres como desvantagem social. In *Annals of the XI Encontro Nacional de Estudos Populacionais* (pp. 1095–1117). Associação Brasileira de Estudos Populacionais.

- Stoebenau, K., Heise, L., Wamoyi, J., & Bobrova, N. (2016). Revisiting the understanding of 'transactional sex' in sub-Saharan Africa: A review and synthesis of the literature. *Social Science & Medicine*, 168, 186–197. <https://doi.org/10.1016/j.socscimed.2016.09.023>
- Svanemyr, J. (2019). Adolescent pregnancy and social norms in Zambia. *Culture, Health & Sexuality*, 22(6), 615–629. <https://doi.org/10.1080/13691058.2019.1621379>
- UNESCO. (2010). Reaching the marginalized: EFA global monitoring report (2010). <https://www.unesco.org/gem-report/en/reaching-marginalized>
- UNESCO. (2020). Inclusion and education | Global education monitoring report. <https://www.unesco.org/gem-report/en/inclusion>
- UNICEF. (2015). UNICEF annual report 2015. <https://www.unicef.org/reports/unicef-annual-report-2015>
- United Nations. (2013). World population prospects, the 2012 revision. <https://www.un.org/en/development/desa/publications/world-population-prospects-the-2012-revision.html>
- World Bank. (1995). *World development report 1995*. The World Bank.
- World Bank. (2000). *World development report 2000/2001: Attacking poverty*. The World Bank.
- World Bank. (2019). *World development report 2019: The changing nature of work*.
- Ziedenberg, J., Communications, L., Johnson, L., Sabol, W., Minton, T., & Harrison, P. (2007). *Education and public safety*. Justice Policy Institute. [https://justicepolicy.org/wp-content/uploads/2022/02/07-08\\_rep\\_educationandpublicsafety\\_ps-ac.pdf](https://justicepolicy.org/wp-content/uploads/2022/02/07-08_rep_educationandpublicsafety_ps-ac.pdf)