

Final Report

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Introduction

In this project, we chose to research what factors in our world influences the rate of teenage pregnancies. We consider premature pregnancies to be a very significant indicator of a country's development and prosperity. Considering the repercussions of lost economic contributions and dependency on costly public programs [<https://www.ncbi.nlm.nih.gov/books/NBK219229/>], we hope our findings can spur a decrease in the rate of teenage pregnancies by encouraging governments to focus on the strongest predictor variables linked to adolescent births.

In essence, we attempt to answer how a country's quality of life, measured by human and economic resources, correlates to the birth rates for teenagers aged 15 to 19 years old. To answer our question, our explanatory variables of adolescent pregnancy rates are female educational attainment, GDP annual growth rate, life expectancy at birth, HDI, labor force participation rate, and gender inequality index.

Information provided by Youth.gov supports our predictors because they broadly encompass the individual, family, and community that influence teenage pregnancies (Youth.gov).

As a note, we acknowledge that our findings are based on preconceived, Western assumptions of what qualifies as a global indicator of "status." Thus, we conducted this report on our assumptions of what defines a country's prosperity and development.

Methodology

There were a few sources that our data was obtained. We mainly worked with the 2020 Human Development Report, courtesy of the United Nations Development Programme. With a vast array of variables available to analyze, we selected female educational attainment (number of years of schooling), GDP and related economic indicators, adolescent birth rate, life expectancy at birth, maternal mortality rate, HDI index, labor force participation rate, and the gender inequality index. We also obtained additional data on adolescent birth rates from the World Health Organization who collected the results via various national and international surveys and country reports, though this dataframe was largely utilized for reference purposes.

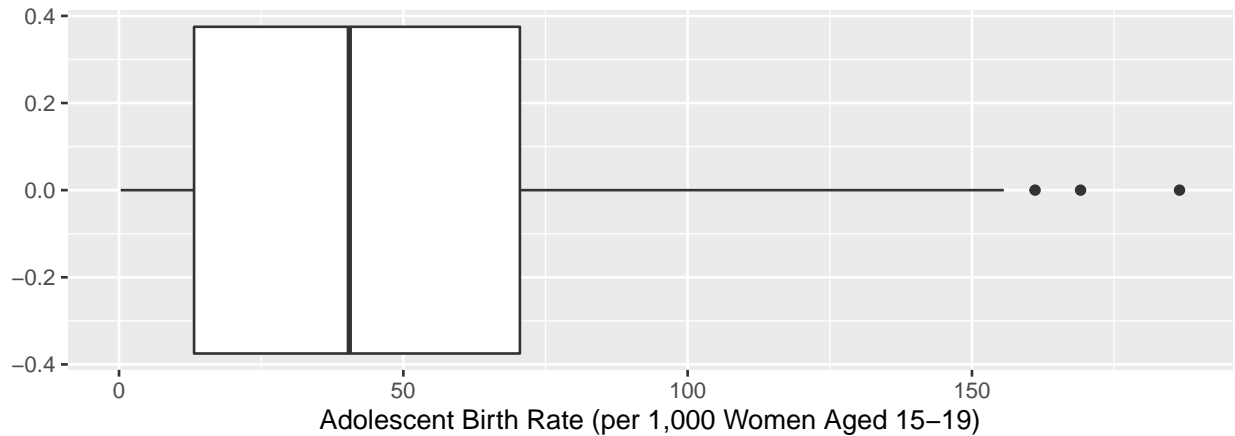
The logic of constructing our project was to try and explore different relationships between these variables and try to create combinations that lead back to their effect(s) on adolescent birth rates. There are many different ways of exploring this data and to create the clearest, most straightforward analysis we created various plots and analyses. Ultimately, we seek to maximize our explanatory power in the relationship between a country's resources and adolescent birth rates and identifying those specific variables that really move the needle.

Intro to data

To allow the reader a complete understanding of our findings, we first focused on analyzing our main variable of interest, adolescent birth rates. Utilizing data from 195 countries, we produced a density plot and corresponding quantile values below. We would like to note that throughout the report adolescent birth rate is measured as the number of births per 1000 women aged 15-19 years old in a given population.

Adolescent Birth Rates Worldwide

Collected in 2019



```
##    0%    25%    50%    75%   100%
##    0.3   13.2   40.5   70.5  186.5
```

We see that the middle 50% of countries have a teenage birth rate between 13.4 and 72.9. Considering a low birth rate is 10-20 births per 1,000 women and a high birth rate is 40-50 births per 1,000 women (Child Trends), our box plot shows a relatively broad distribution rate. Thus, this right-skewed distribution can allow us to compare indicators on both sides of the spectrum. We also have a few outliers, which are Chad (161.1), Mali (169.1), and Niger (186.5). All three have HDI ranks 187, 184, and 189, respectively.

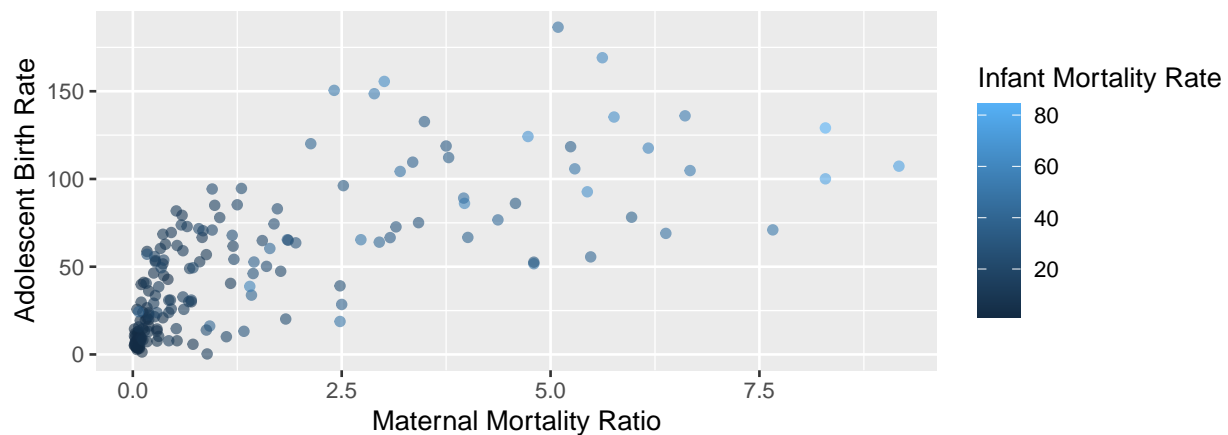
Relationships

After looking at the distribution of birth rate data, we decided to explore if there was a relationship between our chosen factors and adolescent pregnancy rates. Therefore, we plotted our seven explanatory variables (maternal mortality rate, female educational attainment, GDP, life expectancy at birth, 2019 HDI index, and gender development index) onto separate scatter plots. The relationships will then be modeled with a linear regression to determine the significance of adolescent birth rates as an independent indicator has.

Is Maternal Mortality Ratio Related to Adolescent Birth Rate?

Does Maternal Mortality Ratio Affect Adolescent Birth Rate?

Per 1,000 Live Births

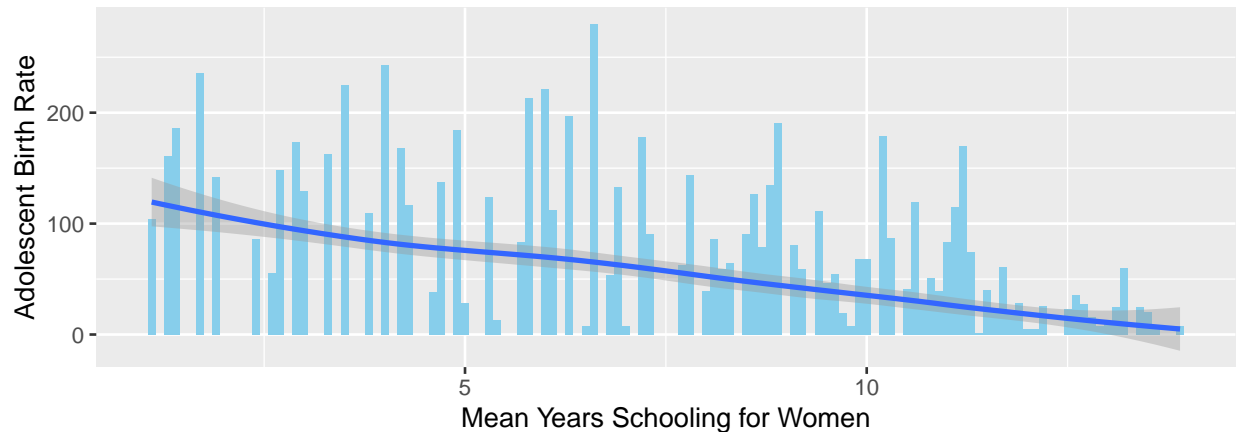


```
## [1] 0.7175514
```

The data shows a positive, linear trend, and we see that as maternal mortality increases, so does adolescent birth rate across countries. We expect countries with higher adolescent birth rates to have high maternal mortality ratios, which can be due to lack of access to modern healthcare among other factors. The relationship between the two variables is positive and relatively strong, considering the correlation coefficient is 0.731. Additionally, we overlaid another variable of infant mortality rates for each of the countries. We clearly see that this trend continues to have this relationship of higher maternal mortality rates and adolescent birth rates also contributes to higher infant mortality rates.

Is Female Educational Attainment Related to Adolescent Birth Rate?

Does Female Educational Attainment Affect Adolescent Birth Rate?
Per 1,000 Live Births

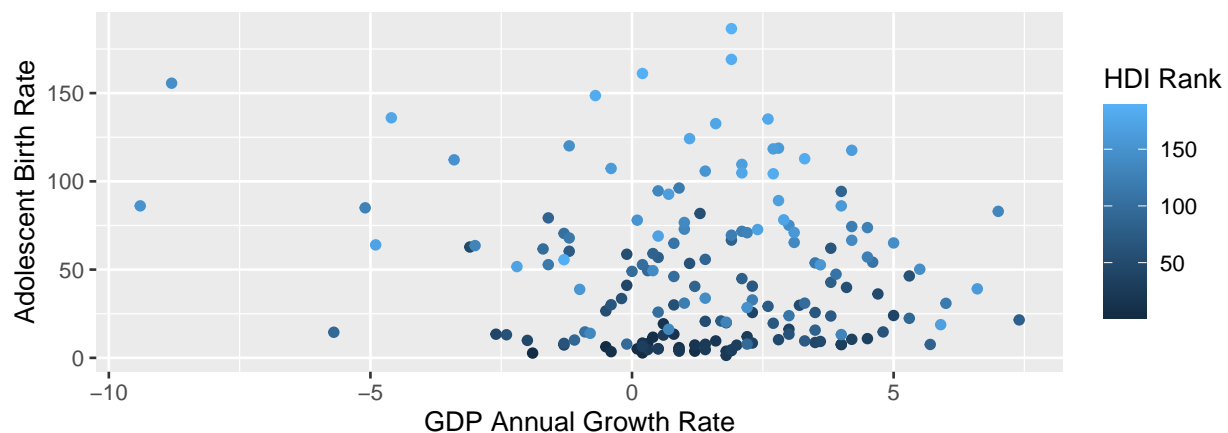


```
## [1] -0.7041979
```

This graph highlights a relatively strong negative correlation ($r = -0.7249$) that for a given country, as the mean years of schooling for women increases, the rate of adolescent births decreases. This logically makes sense because the increase in time spent in school also raises the likelihood of women finding a career in the workforce along with being actively informed about sexual health and safe practices. These factors directly contribute to an overall lower adolescent birth rate.

Is GDP Annual growth rate related to adolescent birth rate?

Does GDP Annual Growth Rate Affect Adolescent Birth Rates?
per 1000 Live Births



```
## [1] -0.1668382
```

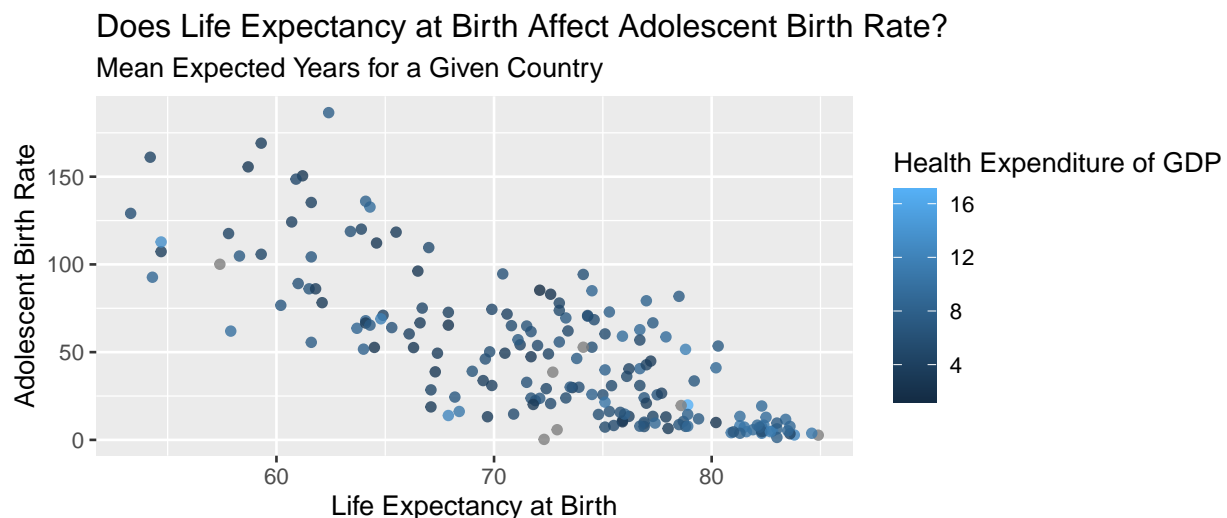
```
## # A tibble: 6 x 5
##   term                estimate std.error statistic  p.value
##   <chr>              <dbl>    <dbl>    <dbl>    <dbl>
## 1 (Intercept)        78.7      5.66     13.9     1.86e-29
## 2 GDP_num            -0.000755  0.000957  -0.789    4.31e- 1
## 3 GDP_Annual_Growth  -2.84      0.927    -3.07     2.53e- 3
## 4 GDP_per_Capita      0.000801  0.000651   1.23     2.21e- 1
## 5 Consumer_Price_Index -0.0000706 0.0229    -0.00308 9.98e- 1
## 6 GNI_Per_Capita     -0.00213   0.000694  -3.07     2.52e- 3
```

We next asked ourselves if strictly economic indicators can be telling in differences in adolescent birth rate. The results were much more muddy than anticipated. For example, we plotted Gross Domestic Product (GDP) annual growth rate, which signifies the yearly average rate of change of GDP at market prices based on constant local currency, for a given national economy, during a specified time (The Balance). The plot shows an unclear relationship between GDP annual growth rate and adolescent birth rate. It is to be noted, however, that the HDI index has a substantial impact on the rate of adolescent births as clearly shown on the plot delineated by color.

We further explored the relationships with economic variables such as GDP, Consumer Price Index, GNI (Gross National Income) per Capita using a linear regression model to seek if economic indicators on their own can tell about adolescent birth rates in a given country. GDP Annual Growth and GNI per Capita were the two economic indicators that were the most significant in the model, though both failed to reach the appropriate p-level threshold to be counted as statistically significant.

Finally, we calculated the correlation coefficient and found a very weak, negative relationship ($r = -0.1261$). We can therefore conclude that just by looking at a given country's economic condition and growth is a fairly poor indicator of the adolescent birth rate. This definitely makes sense since there are many developing nations with high GDP growth but still lack advanced infrastructure for healthcare, while there are low growth GDP countries that have reached the post modern classification and have highly robust healthcare access.

Is life expectancy at birth related to adolescent birth rate?



```
## [1] -0.7784798
```

This graph shows a strong, negative, linear relationship ($r = -0.778$) between life expectancy at birth and adolescent birth rate, meaning as life expectancy increases, adolescent birth rate decreases. This makes logical sense because women would have less need to reproduce if their children are expected to have a long lifespan. In addition, we applied an overlay of Health Expenditure of GDP to study if this variable affects both life

expectancy and adolescent birth rates. As seen, there is not an extremely clear pattern exhibited, but in general the trend tends to be that those countries with a higher devotion of Health Expenditure relative to their GDP came out to longer life expectancies and lower adolescent birth rates.

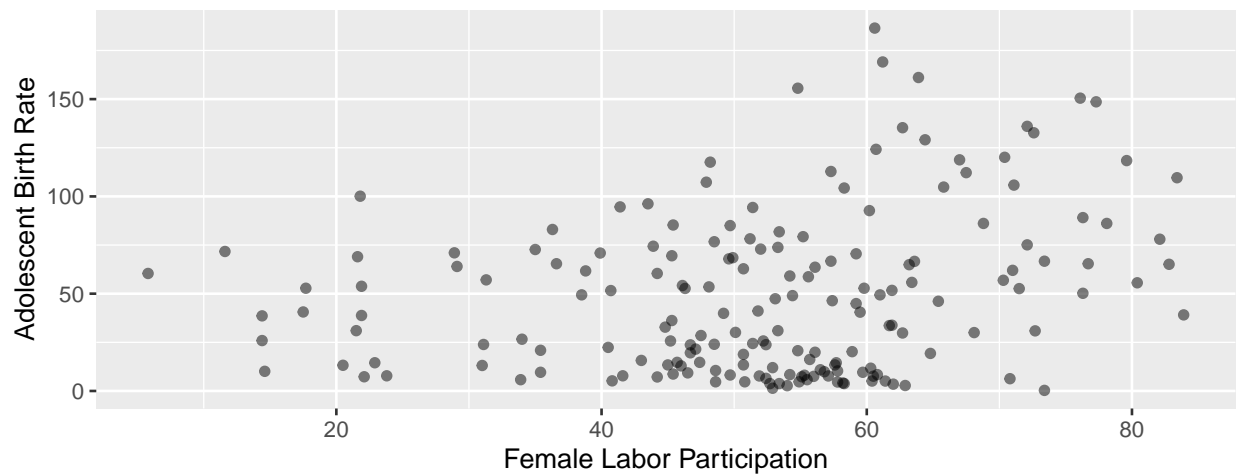
Is HDI in 2019 related to adolescent birth rate?

```
## [1] -0.7741174
```

HDI, also known as the Human Development Index, is a statistic used to rank countries. There is clearly a relatively strong negative linear relationship ($r = -0.774$) between 2019 HDI and adolescent birth rate (per 1,000 women aged 15-19 years old), meaning as the HDI increases, the rate of adolescent birth rates decrease. This relationship makes sense because unlike that of other economic indicators like GDP and GNI above, HDI is a more holistic indicator of a country's resources, its condition both economically and health-wise, and the level of democracy that exists. The confluence of these factors helps to build the HDI index and therefore it commands a far better relationship with adolescent birth rates than many other single standing variables.

Is labor force participation rate related to adolescent birth rate?

Does Female Labor Participation Affect Adolescent Birth Rate?

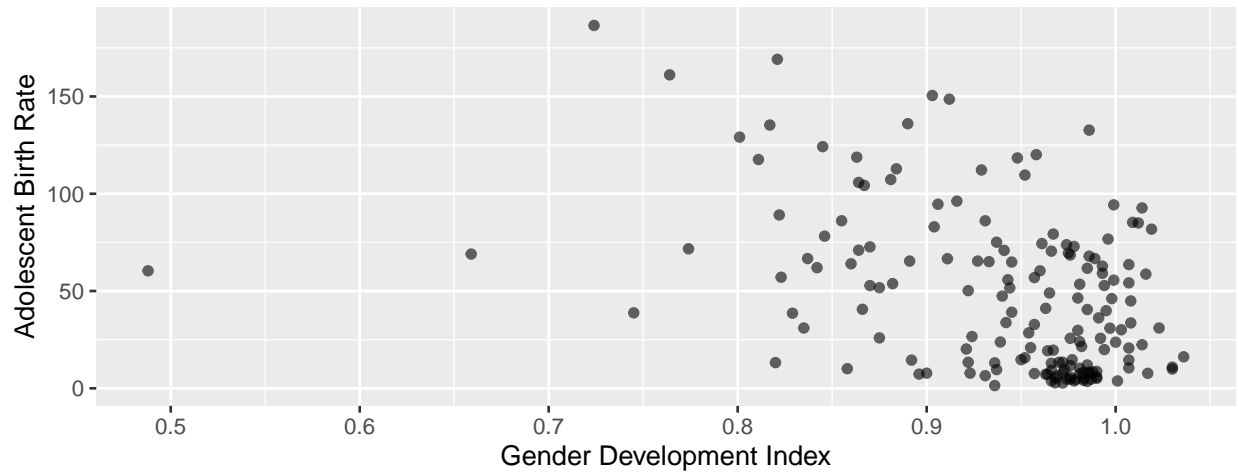


```
## [1] 0.2551033
```

From the plot, we only somewhat see a relationship between female labor participation and adolescent birth rate, and our correlation coefficient of 0.3103 confirms a weak, positive linear correlation. Roughly, as female labor participation increases, the birth rate per 1,000 women aged 15-19 years old also increases. This is slightly surprising because we predicted that countries with high teenage birth rates would have higher female labor participation levels. We assumed the young women would be at home, mainly because we saw this earlier with female educational attainment.

Is the gender develop index related to adolescent birth rate?

Is Gender Development Index Related to Adolescent Birth Rate?



```
## [1] -0.4247212
```

The gender development index measures gender inequality through gender-based gaps in education, life expectancy, and incomes, and the closer the value is to 1, the more equal a society is. We see that as the gender development index approaches 1, there is a slight linear decrease ($r = -0.5148$) in adolescent birth rate (per 1,000 15-19-year-olds). This relationship makes sense because we assume that more equal societies would allow women to make their own reproductive choices. They are also more likely to have resources and healthcare options for women.

Linear regression

After looking to see possible relationships, we decided to run a linear regression analysis in order to determine which predictors had the most influence over teenage pregnancy rates and what that relationship is. The general null hypothesis test for every explanatory variable is $\beta = 0$, which indicates that there is no difference in influence when we control for each one individually.

Which variable has the most significant correlation to adolescent birth rate?

```
## # A tibble: 8 x 7
##   term                estimate std.error statistic    p.value  conf.low conf.high
##   <chr>              <dbl>    <dbl>    <dbl>    <dbl>    <dbl>    <dbl>
## 1 (Intercept)        15.0      55.7      0.269  7.88e-1  -9.53e+1  125.
## 2 GDP                0.00840   0.00851    0.986  3.26e-1  -8.45e-3  0.0252
## 3 Maternal_Mortalit~ 0.0193    0.0161    1.20   2.33e-1  -1.26e-2  0.0512
## 4 Mean_Years_School~ 2.04      1.54      1.32   1.89e-1  -1.01e+0  5.08
## 5 Life_Expectancy_B~ -0.130    0.775    -0.167  8.67e-1  -1.66e+0  1.40
## 6 HDI_2019          -79.7     58.8     -1.36   1.77e-1  -1.96e+2  36.6
## 7 Labour_Participat~ 0.607     0.138     4.39   2.40e-5  3.33e-1  0.881
## 8 Gender_Inequality~ 135.      26.1      5.17   8.75e-7  8.33e+1  187.
```

Interpretation

Out of the seven variables we fitted in the linear regression, we see that only two explanatory variables (female labor participation and gender inequality index) have p-values smaller than our alpha 0.05 ($2.395e^{-05}$ and $8.747e^{-07}$, respectively). Thus, these two variables reject our null hypothesis that there is no difference in influence over all of the explanatory predictors.

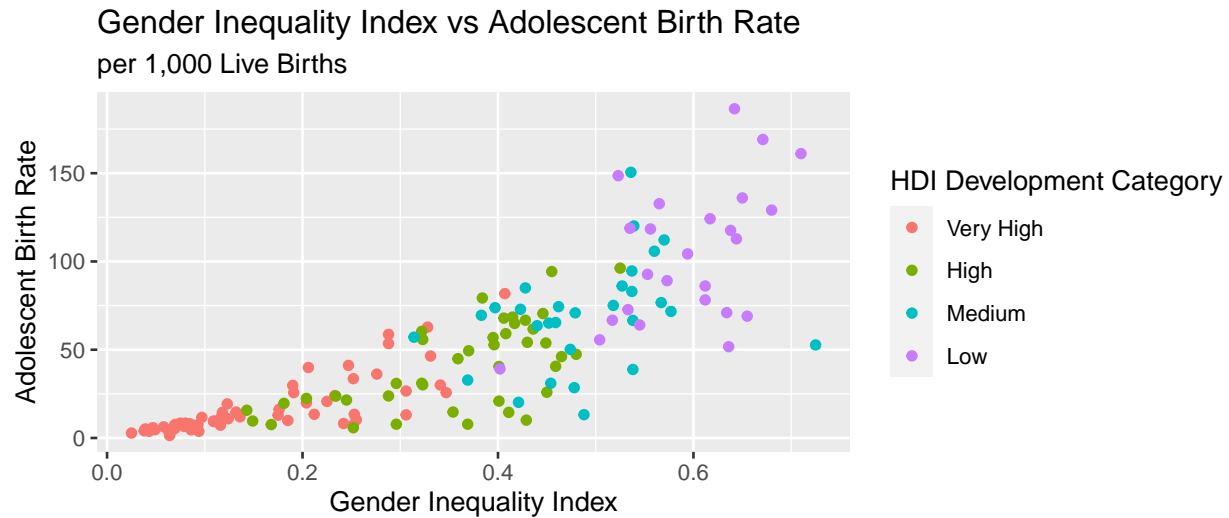
To break this down, in a hypothesis test for female labor participation where $H_0 : \beta_6 = 0$ and $H_a : \beta_6 \neq 0$,

our rejection of the null hypothesis indicates an estimated 134.9 increase in adolescent birth rate, holding all other variables constant. Additionally, the 95% confidence interval ($3.332e^{-01}$, 0.8806) doesn't contain 0.

In a separate hypothesis test for gender inequality index where $H_0 : \beta_7 = 0$ and $H_a : \beta_7 \neq 0$, our rejection of the null hypothesis indicates an estimated 0.606 increase in adolescent birth rate, holding all other variables constant. Additionally, the 95% confidence interval ($8.33e^1$, 186.5) doesn't contain 0.

Furthermore, considering comparatively higher correlation between gender inequality index and adolescent birth rate, we decided to further analyze this variable in a more detailed scatter plot below.

Looking further at Gender Inequality Index



The gender equality index measures the gender disparity in a country on a scale from 0 to 1. The greater the value, the greater the measure of inequality.

HDI reflects economic prosperity in a country, so we broke the HDI rankings up into four categories to visualize the hypothesis that wealth plays a major roll in access to equality. Since gender inequality is such a broad issue we wanted to look at wealth desperation in conjunction. This plot supports the idea that wealthier countries tend to have lower gender equality disparities and lower rates of teen births, and vice versa. Our plot, organized by HDI rank, can help us select which countries will benefit most from our intervention targeting wealth and gender inequality to improve adolescent birth rates.

Summary & Next Steps

In summation, although we recognize that correlation does not mean causation, we recommend that the intervention created to reduce the number of adolescent births focus on the communities with the highest rates, countries with low HDI rank, and do so by addressing the gender inequality in these countries. Since we have a finite amount of resources, it is best to put them towards low HDI countries. Since our highest correlating variable was gender inequality, the most efficient way to help adolescent birth rates decrease will be to try and close this gap. Some ways that can help close the gender equality gap are encouraging girls to stay in school and pursue education. If girls acquire skills that make not just their bodies, but their minds valuable to society then they will be encouraged to pursue careers and higher degrees, thus waiting to have children until they are older. Women who give birth later in life don't only have less pregnancy related health risks than teen mothers, but they are also more economically stable, and therefore able to give their children a better quality of life.