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# Global Trends in Adolescent Fertility, 1990–2012, in Relation to National Wealth, Income Inequalities, and Educational Expenditures

John S. Santelli, M.D., M.P.H. [a,*], Xiaoyu Song, Dr.P.H. [a], Samantha Garbers, Ph.D. [a], Vinit Sharma, M.D. [b], and Russell M. Viner, Ph.D. [c]

[a] *Heilbrunn Department of Population and Family Health, Mailman School of Public Health, Columbia University, New York, New York*
[b] *UNFPA, Regional Office for Asia and Pacific Region, Bangkok, Thailand*
[c] *UCL Institute of Child Health, University College London, London, United Kingdom*

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A B S T R A C T

**Purpose:** National wealth, income inequalities, and expenditures on education can profoundly influence the health of a nation's women, children, and adolescents. We explored the association of trends in national socioeconomic status (SES) indicators with trends in adolescent birth rates (ABRs), by nation and region.
**Methods:** An ecologic research design was employed using national-level data from the World Bank on birth rates per 1,000 women aged 15–19 years, national wealth (per capita gross domestic product or GDP), income inequality (Gini index), and expenditures on education as a percentage of GDP (EduExp). Data were available for 142 countries and seven regions for 1990–2012. Multiple linear regression for repeated measures with generalized estimating equations was used to examine independent associations.
**Results:** ABRs in 2012 varied >200-fold—with the highest rates in Sub-Saharan Africa and lowest rates in the Western Europe/Central Asia region. The median national ABR fell 40% from 72.4/1,000 in 1990 to 43.6/1,000 in 2012. The largest regional declines in ABR occurred in South Asia (70%), Europe/Central Asia (63%), and the Middle East/North Africa (53%)—regions with lower income inequality. In multivariable analyses considering change over time, ABRs were negatively associated with GDP and EduExp and positively associated with greater income inequality.
**Conclusions:** ABRs have declined globally since 1990. Declines closely followed rising socioeconomic status and were greater where income inequalities were lower in 1990. Reducing poverty and income inequalities and increasing investments in education should be essential components of national policies to prevent adolescent childbearing.


**IMPLICATIONS AND CONTRIBUTION**

Declines in national adolescent birth rates from 1990 to 2012 were profoundly and independently shaped by national income, income inequalities, and expenditures on education. National strategies to reduce adolescent fertility should include investments in economic development, job creation, and improvement and expansion of schooling—in addition to improving access to contraception.

Adolescent fertility declined dramatically around the globe during the second half of the 20th century, reflecting enhanced educational, occupational, and economic opportunities for young women; rising age at marriage; greater access to modern contraception; and safe abortion [1–3]. While adolescent fertility has

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* Address correspondence to: John S. Santelli, M.D., M.P.H., 60 Haven Avenue, B2, New York, NY 10032.
*E-mail address:* js2637@columbia.edu (J.S. Santelli).

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fallen markedly in high-, middle-, and low-income nations, high adolescent birth rates (generally accompanied by high total fertility) persist in many countries, particularly in Sub-Saharan Africa [4]. By contrast, in Western Europe and other high-income countries, adolescent birth rates are now very low: the European Union region had an adolescent birth rate of only 10.7/1,000 women aged 15–19 years in 2013 [5], although, among high income nations, the United States continues to have among the highest rates of adolescent fertility (27/1,000 in 2013), despite a decline of 51% between 1990 and 2012 (the period of time for this study) [6].

Fertility among adolescents is influenced by a multitude of social, structural, biological, and behavioral factors. These include factors reducing adolescent fertility risk such as educational and employment opportunities, robust economic development, family stability, prosocial cultural norms, contraceptive use, and access to safe abortion. Factors increasing risk of fertility include greater income disparities and earlier age at menarche, at first sex, and at first marriage [7–9]. Importantly, social and structural factors such as socioeconomic status (SES) directly influence behavioral factors such as contraceptive use [10–12]. Comparing research findings from high-income and low- and middle-income countries, factors such as poverty, family instability, and education appear to influence adolescent sexual behaviors in similar ways, despite enormous differences in social context [9,13]. Adolescent childbearing is associated with adverse health and social consequences for the mother and the child; poverty and social deprivation are both causes and consequences of adolescents becoming parents [14].

A key social structural influence on adolescent fertility is SES. SES can be measured at a national level as per capita gross domestic product (GDP); at an individual level, SES is generally measured as family or household income or as parents' educational attainment. National rates of adolescent fertility are associated with national income and parental educational attainment, as well as SES disparities within nations [15,16]. For example, the pattern of higher rates of adolescent fertility in the United States compared with other high income nations has been ascribed to greater SES disparities within the United States [16]. Within the United States, adolescent birth rates in states and smaller areas are strongly associated with per capita income, disparities in income, proportion of families living in poverty, educational attainment among adults aged 25+ years, adult unemployment, social capital, and the proportion of the population who are members of disadvantaged minority groups [17–19]. Similar associations of adolescent birth rates with poverty and income inequality have been found among cities in Brazil, a middle-income country with considerable income inequalities [20]. Given these relationships, poverty reduction within nations, removing regional inequalities and disparities, and promoting economic development of nations could have important impacts in reducing adolescent birth rates and in improving health and social outcomes for women and children.

In this study, we examined the effects of national income (per capita GDP), income inequality within nations (the Gini Index), and national expenditures on education as a percentage of GDP on adolescent birth rates and rates of decline in adolescent fertility among 142 nations over the period 1990–2012. We hypothesized that GDP, Gini, and educational expenditures would be independently associated with national rates of adolescent births and trends in these rates. To our knowledge, this is the most comprehensive examination of income and income inequalities and their relationship to trends in global adolescent fertility.

## Methods

Country-level data on adolescent birth rates, GDP, Gini index, and education expenditures were retrieved from the World Bank online Open Data database (http://data.worldbank.org/) [5]. Sources for these data were authoritative national estimates drawn from registration data provided by national statistical offices or regional organizations (e.g., European Union, the Pacific Community) and from international surveillance studies such as the Demographic and Health Survey or the UNICEF Multiple Indicator Cluster Survey. World Bank data on adolescent birth rates come from the United Nations.

In the data set, adolescent birth rates were based on the number of births per 1,000 adolescent women (aged 15–19 years) [5]. Per capita gross domestic product (GDP) in current U.S. dollars was used as the indicator of wealth [5]. The Gini index (range 0–100), the most commonly used measure of national income inequality, was also used for this study [5]. A Gini score of 0 corresponds with perfect equality (where everyone has the same income), and a score of 100 corresponds with perfect inequality (i.e., one person has all the income). Thus, a higher national Gini index score indicates greater income inequality within a nation. The Gini index is as valid as people's reports of income are valid; our data suggest that Gini scores are reliable given strong correlation across years within each nation reporting data. Educational expenditures were calculated as the total government expenditure on education expressed as a percentage of GDP [5].

With the exception of Gini index, data were available for most years in high income countries, but the majority of middle- and low-income countries had incomplete data sets due to lack of data in particular years. Many countries do not report economic data every year. Thus, data were missing for Gini from 70.0% of country-years of observation, EduExp (46.5% of country-years), GDP (3.2%), and adolescent birth rates (0%). Because data for Gini and EduExp for most countries did not change or changed slowly over time, we were able to use nearest neighbor imputation for years where data were missing. Although GDP did change over time, the number of years with missing data was low; thus, we also used nearest neighbor imputation. The most recent data on adolescent birth rates in the majority of countries were from 2013; data on GDP and EduExp were available through 2014, whereas Gini data were only available through 2012. Thus, these analyses were limited to the period 1990–2012. Data were limited to the 142 countries which had available data on ABR, GDP, Gini, and EduExp in at least 1 year. Countries (n = 52) were dropped because of missing data (generally on Gini index); these countries came from all regions of the world and were primarily smaller countries, island nations, and city–states, or countries with weak health systems. Data were also examined by region, using World Bank region designations, including East Asia/the Pacific (n = 14 countries), Europe and Central Asia (n = 42), Latin America and the Caribbean (n = 24), the Middle East and North Africa (n = 10), North America (n = 2), South Asia (n = 8), and Sub-Saharan Africa (n = 42).

### *Analyses*

We examined ABR using data from 2012, first describing the ABR by country and region. Then, the bivariate association between the ABR and each macroeconomic factor in 2012 was tested for all countries. Using scatterplots, the relationships

between ABR and GDP, Gini, and EduExp were visually represented, and correlation coefficients were calculated.

Finally, bivariate and multivariable regression models were developed with ABR as the dependent variable for each macroeconomic indicator and then including all indicator variables over time. In exploratory scatterplots, ABR was found to be potentially linearly associated with GINI and ExpEdu but exponentially associated with GDP. Therefore, we modeled the association between ABR and year, log-transformed GDP, GINI, and ExpEdu using simple and multiple regressions. The regression coefficients were estimated with generalized estimating equations to account for the correlations from the repeatedly measured countries over time. For multivariable models, data were available for 142 countries and 23 years (3,266 country-year observations).

### *Research ethics*

We used publicly available data on adolescent birth rates and published data on national economic indicators without patient or individual subject data. Analysis of aggregated, anonymized data does not constitute human subjects research and therefore is exempt from Institutional Review Board/ethics committee review.

## Results

Adolescent birth rates in 2012 varied more than 200-fold among 142 nations examined. The highest rate of adolescent births was found in Niger at 205/1,000, whereas the lowest rates were found in Slovenia at <1/1,000. By region, the highest rates were found in Sub-Saharan Africa and lowest rates in Europe and Central Asia and other high-income nations. Among the 20 countries with an ABR <10/1,000, 14 countries were in Europe and Central Asia, 3 were in East Asia or the Pacific region, 2 were in the Middle East or North Africa, and 1 was in South Asia (Maldives). Among high-income countries in 2012, the ABR was 31/1,000 in United States, 25.8 in the United Kingdom, 14.5 in Canada, 6.5 in Sweden, 6.2 in the Netherlands, 5.7 in France, 3.8 in Germany, and 1.9 in Switzerland.

### *Changes over time*

Worldwide, the median national adolescent birth rate was 72.4/1,000 (with an interquartile range (IQR) of 41.3–81.7) in 1990; by 2012, it had declined 40% to 43.6/1,000 (IQR: 17.2–80.1; Table 1) Overall, 136 of 142 nations showed declines in ABR between 1990 and 2012; 6 showed increases (Azerbaijan, Guyana, Japan, Lesotho, Mozambique, and Zambia). The most dramatic decline in median ABR occurred in South Asia: in 1990, the South Asia regional median was 121.3, close to the median for Sub-Saharan Africa at 131.7 (Table 1 and Figure 1). By 2012, the median for South Asia had dropped to 36.9 (a decline of 70%), lower than the global median at 43.6. Sizeable declines were evident in Europe and Central Asia (63%), the Middle East and North Africa (53%), and North America (44%), whereas the smallest declines occurred in Latin America and the Caribbean (22%), Sub-Saharan Africa (25%), and East Asia and the Pacific (31%).

The largest regional declines in ABR occurred in the three regions with the lowest Gini index scores in 1990 (South Asia, Europe and Central Asia, and the Middle East and North Africa). Among the 142 nations, the correlation between initial Gini score and percentage change in the ABR from 1990 to 2012 was $R = .25$. Likewise, the correlations between ABR and initial log GDP and initial EduExp were −.26 and −.20, respectively.

**Table 1**
Median adolescent birth rates (ABRs) and socioeconomic indicators in 1990 and 2012, and change over time by region

| | Number of countries | 1990 | 2012 | % change 1990–2012 |
|---|---|---|---|---|
| Country median ABR | | | | |
| Worldwide | 142 | 72.4 | 43.6 | −39.8 |
| East Asia and Pacific | 14 | 50.5 | 35.0 | −30.7 |
| Europe and Central Asia | 42 | 35.5 | 13.1 | −63.0 |
| Latin America and Caribbean | 24 | 90.7 | 70.4 | −22.4 |
| Middle East and North Africa | 10 | 61.4 | 29.0 | −52.7 |
| North America | 2 | 40.7 | 22.8 | −44.1 |
| South Asia | 8 | 121.3 | 36.9 | −69.6 |
| Sub-Saharan Africa | 42 | 131.7 | 98.8 | −25.0 |
| Country median GDP per capita | | | | |
| Worldwide | 142 | $1,195 | $4,398 | 268.1 |
| East Asia and Pacific | 14 | $944 | $4,057 | 329.8 |
| Europe and Central Asia | 42 | $3,408 | $14,206 | 316.8 |
| Latin America and Caribbean | 24 | $1,713 | $6,153 | 259.1 |
| Middle East and North Africa | 10 | $1,235 | $3,727 | 201.7 |
| North America | 2 | $22,628 | $52,095 | 130.2 |
| South Asia | 8 | $368 | $1,368 | 271.6 |
| Sub-Saharan Africa | 42 | $411 | $915 | 122.7 |
| Country median Gini index | | | | |
| Worldwide | 142 | 39.6 | 38.2 | −3.8 |
| East Asia and Pacific | 14 | 34.7 | 36.8 | 6.0 |
| Europe and Central Asia | 42 | 31.5 | 31.2 | −.8 |
| Latin America and Caribbean | 24 | 51.3 | 46.6 | −9.2 |
| Middle East and North Africa | 10 | 37.5 | 35.9 | −4.4 |
| North America | 2 | 34.4 | 37.4 | 8.8 |
| South Asia | 8 | 32.9 | 33.2 | 1.1 |
| Sub-Saharan Africa | 42 | 47.1 | 43.0 | −8.7 |
| Country Median Expenditure on Education as % of GDP | | | | |
| Worldwide | 142 | 4.0 | 4.6 | 14.6 |
| East Asia and Pacific | 14 | 3.7 | 4.6 | 24.2 |
| Europe and Central Asia | 42 | 4.6 | 4.7 | 3.5 |
| Latin America and Caribbean | 24 | 3.1 | 4.4 | 42.0 |
| Middle East and North Africa | 10 | 5.3 | 4.8 | −9.6 |
| North America | 2 | 5.4 | 5.2 | −3.0 |
| South Asia | 8 | 2.9 | 3.5 | 22.3 |
| Sub-Saharan Africa | 42 | 3.2 | 4.6 | 41.8 |

Median national GDP in 1990 was $1,195 (IQR: $473–$3,025), and in 2012, it was $4,399 (IQR: $1,293–$12,770), an increase of 268% (IQR: 173%–322%, Table 1). The largest increases in median GDP occurred in East Asia and the Pacific (333%) and Europe and Central Asia (317%, Figure 1). The smallest increases were found in North America (130%) and Sub-Saharan Africa (123%).

The median national Gini index changed very little over time; worldwide, the median national Gini was 39.6 in 1990 and 38.2 in 2012 (a 3.7% decrease) representing a small decline in income inequalities (Table 1 and Figure 1). Latin America and the Caribbean and Sub-Saharan Africa—the two regions with the greatest inequality (highest median Gini index) in 1990—also showed the largest declines in income inequality. North America and East Asia and the Pacific showed the largest increases in inequality (i.e., largest increase in median Gini index).

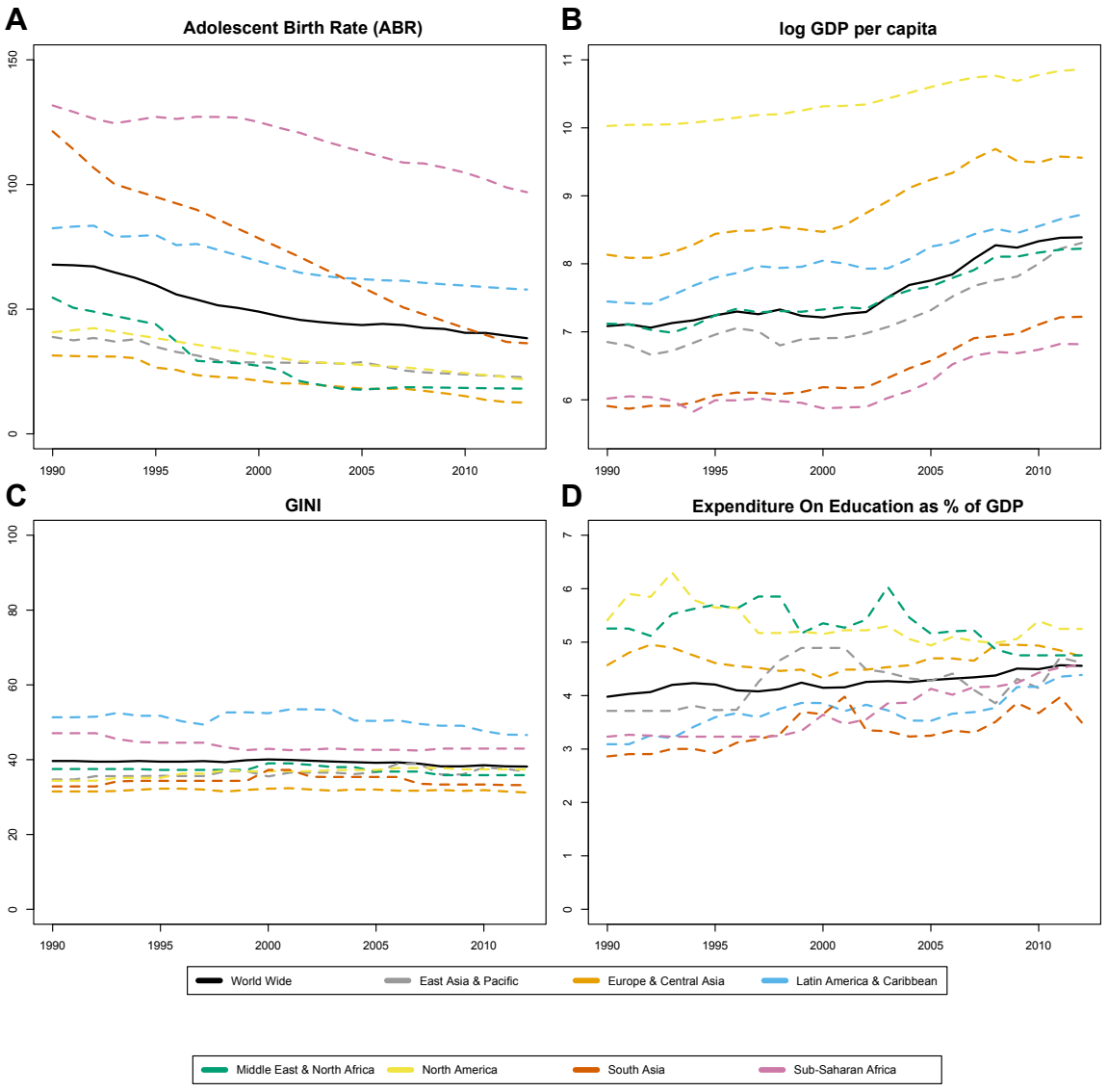


**Figure 1.** Worldwide and regional trends in median ABR (A), log GDP (B), income inequalities (Gini index) (C), and expenditures on education as % of GDP (D), 1990–2012.

The median national expenditures on education among all nations rose 15% from 4.0% of GDP to 4.6% of GDP (Table 1). Given the considerable increase in GDP, the total increase in educational expenditures (multiplying increases in EduExp and GDP) was >300% in 22 years. Considerable regional variation was evident in expenditures on education (Figure 1). The largest increases in the percentage of GDP devoted to education were evident in those regions with the lowest percentage expenditures in 1990 (Latin America with an increase of 42%; Sub-Saharan Africa, 42%; East Asia and the Pacific, 24%; and South Asia, a 22% increase).

*Associations of adolescent birth rate with macroeconomic factors*

In bivariate analyses, we found striking variation in median ABR and in socioeconomic indicators over time—by nation and region. Figures 2–4 show the pattern of associations of ABR with the three socioeconomic factors in 2012. The log GDP shows an inverse relationship to adolescent fertility with higher GDP strongly associated with lower ABR (Figure 2, correlation coefficient = −.669, $p < .001$). Nations were strongly clustered by region—given similarities in ABR and log GDP. The Gini index was positively associated with ABR, indicating that adolescent fertility is higher where income inequalities are greater (Figure 3, correlation coefficient = .364, $p < .001$). EduExp showed a weak correlation with ABR (Figure 4, correlation coefficient = −.199, $p = .018$).

Table 2 shows both unadjusted regression models and fully adjusted regression models predicting national ABR based on year, log GDP, Gini, and EduExp as a percentage of GDP. In the unadjusted models, all four independent variables were significantly associated with ABR. In the fully adjusted model, log GDP, Gini, and expenditures on education were significantly associated with ABR; year (time) was no longer significantly associated with ABR, after adjusting for macroeconomic factors.

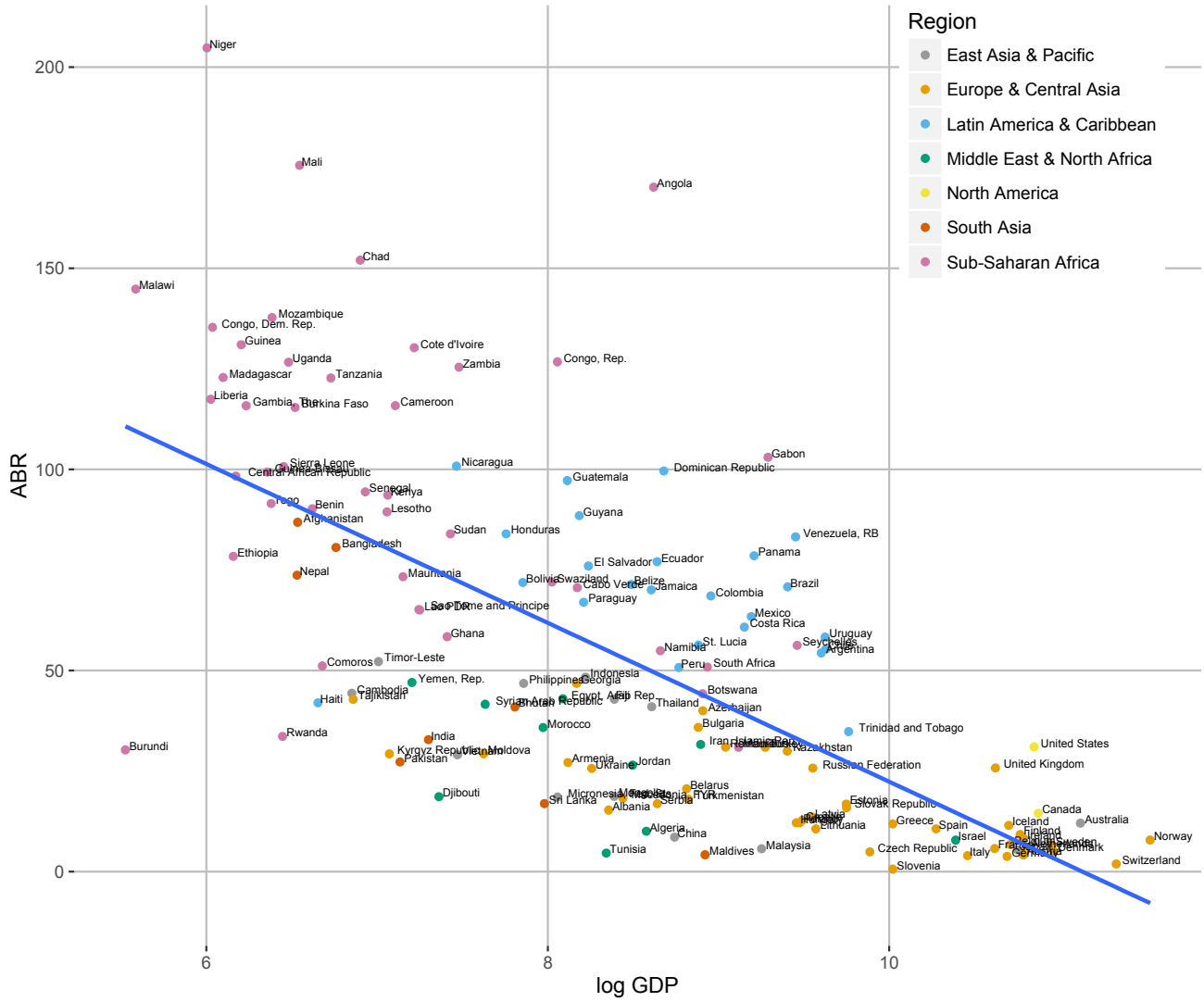


**Figure 2.** National adolescent birth rates by log of the national per capita gross domestic product, 2012. Note: each dot represents 1 nation. N = 142 nations. $R = -.669$, $p < .001$.

## Discussion

Adolescent birth rates vary enormously among nations, and national rates of adolescent fertility are highly associated with national socioeconomic indicators, particularly national per capita GDP and income inequalities. Over the past 22 years, median national rates for adolescent fertility dropped by ~40%, and these declines appear to be profoundly influenced by national income inequality and per capita income. Both national income inequalities (Gini) and absolute income (per capita GDP) were independently associated with rates of adolescent fertility. Even after controlling for GDP and Gini, educational expenditures were also associated with the adolescent birth rates. Examination of time trends suggests that the most important explanation for *declining* rates of adolescent fertility was rising national wealth. A second key explanation for these time trends was income inequalities. While inequalities showed little change over time, regions with lower income inequalities (lower initial Gini scores as measured in 1990) had more rapid rates of decline in adolescent fertility.

Our data analyses also demonstrate that countries with greater national wealth entered the 1990s with substantially lower ABRs and that improvements in GDP were strongly associated with lower ABR over time. In previous studies, rising national income has been associated with multiple factors that might lead to lower adolescent fertility, including increased educational and employment opportunities for women, urbanization, increased access to modern contraception, delay in marriage and childbearing, and reductions in young adult fertility [7,9,11,13,21], suggesting that national development itself as an important mechanism for lowering adolescent birth rates.

In our study, higher income inequalities were associated with higher adolescent fertility and with slower rates of decline in ABR. The impact of inequalities has also been demonstrated in a number of cross-sectional and longitudinal national studies from the United States, Brazil, and among high-income nations

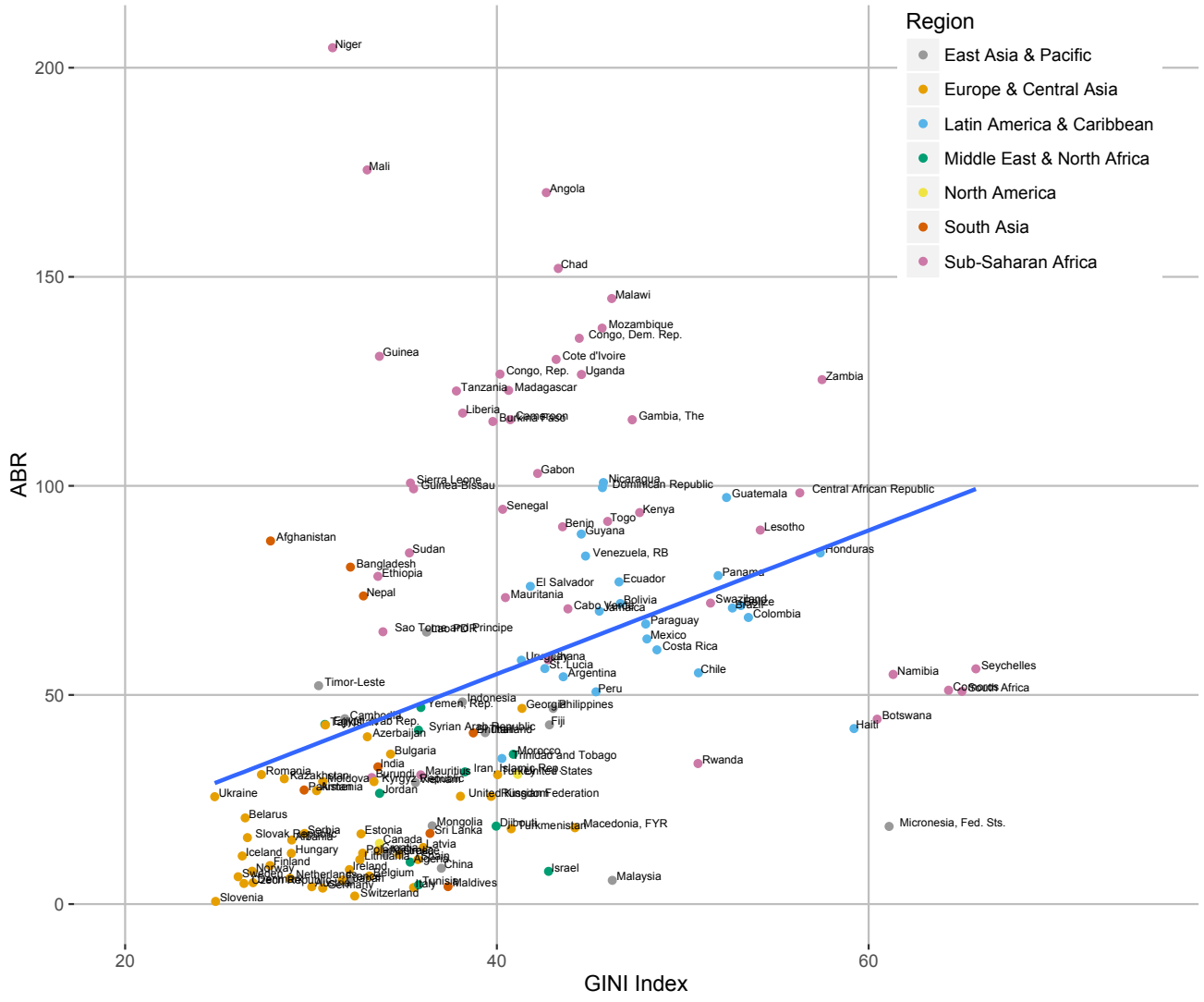


**Figure 3.** National adolescent birth rates by national Gini index, 2012. Note: each dot represents 1 nation. N = 142 nations. $R = .364$, $p < .001$.

[17–22], which demonstrate the association of both higher income and reduced-income inequality with lower adolescent fertility. Consistent with this prior research, our study found that income inequalities may explain the observed difference in ABR between the United States and other high-income nations [16]. The United States has consistently been an outlier among high-income nations—with substantially higher adolescent fertility than western European nations such as France, Sweden, and the Netherlands, nations with lower income inequality compared with the United States [16]. Echoing this pattern, the United Kingdom has an adolescent fertility rate that is intermediate between Western Europe and the United States and has income inequalities that are also intermediate (Figure 3).

While this article examines macroeconomic factors, our findings on educational expenditures, as a measure of socioeconomic opportunities, are consistent with research on proximate determinants of fertility [8–13,16], Proximate determinants—including age at first sex and marriage, contraceptive use, and use of abortion—are commonly associated with socioeconomic factors influence.

Income and income inequalities are associated with other health outcomes for children, adolescents, and adult populations [12–18,20,21,23–25]. Our significant findings on all three dimensions studied—national income, income inequalities, and educational expenditures—therefore parallel previous research on social and structural determinants (SSDs) on adolescent health [15] and the recent Lancet Commission on Adolescent Health and Well-being [26]. Social determinants of health—"the conditions of which people are born, grow, live, work, and age"—profoundly influence multiple areas of adolescent health and social development, including trajectories from childhood into adolescence. Particularly important is the influence of SSD on access to education which is a key pathway to health and well-being [15,26]. SSD also influence the ability of families and communities to promote successful human development through childhood and adolescence.

Although adolescent childbearing is often seen as symptom of socioeconomic disadvantage, early childbearing can also be understood as an adaptive response when other life options are not available. Finally, an additional (and complementary)

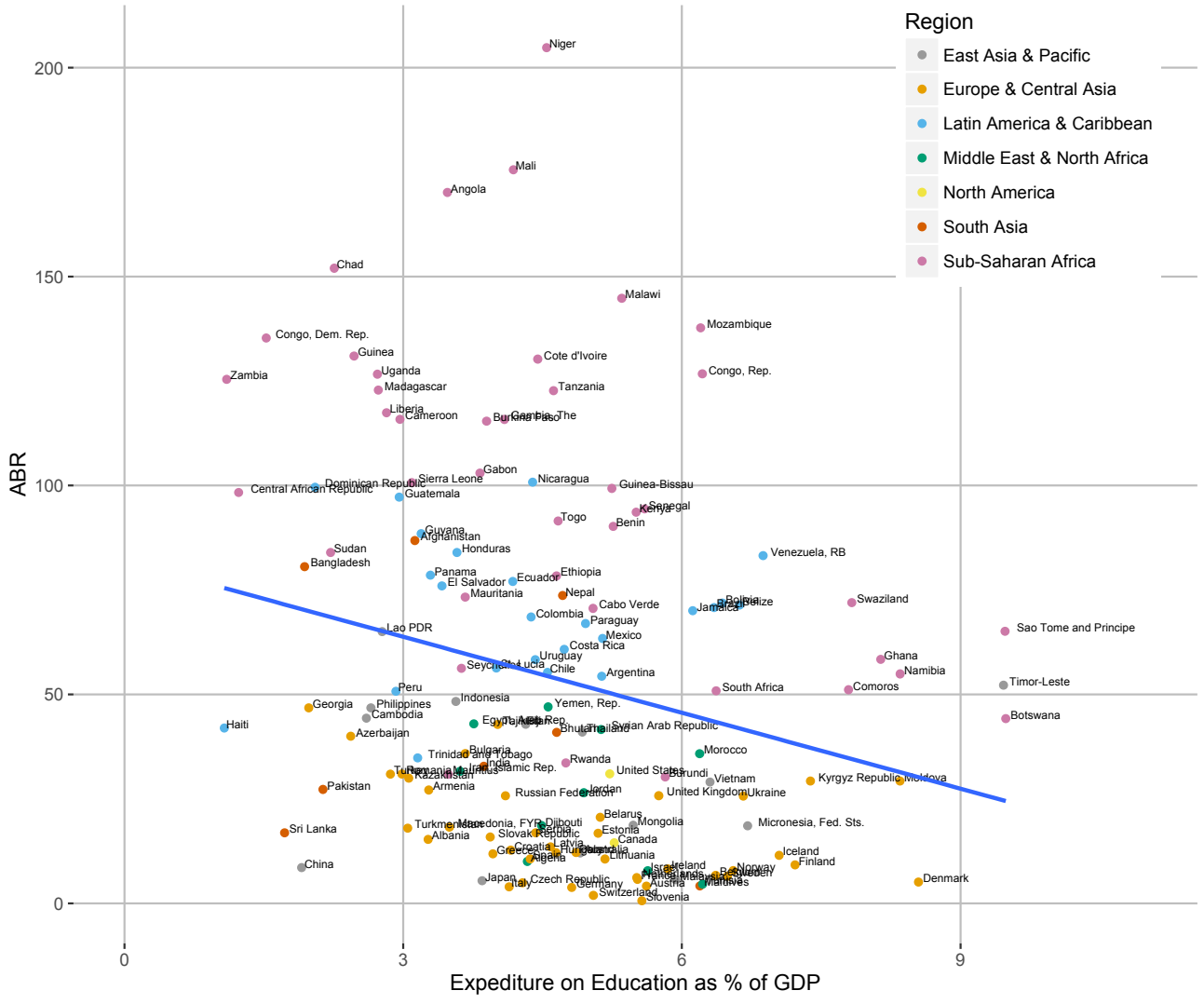


**Figure 4.** National adolescent birth rates by national expenditures on education, 2012. Note: each dot represents one nation, expenditures on education calculated as a percentage of GDP, N = 142 nations. $R = -.199$, $p = .018$.

explanation for our findings is the so-called demographic dividend (the period of declining fertility in response declining infant and child mortality). In the demographic dividend, lower fertility including adolescent fertility leads to improved economic productivity within the population and faster economic growth [27]. While declining adolescent fertility alone is unlikely to influence economic growth, reductions in adolescent birth rates are commonly accompanied by declines in the total fertility rate [3].

### *Limitations*

Our study examined ecological associations at a national level; thus, we are unable to establish causality; we were also

**Table 2**
Socioeconomic risk factors for adolescent birth rates by nation (1990–2012)

| Predictor | Unadjusted regression | | | | Adjusted regression | | | |
|---|---|---|---|---|---|---|---|---|
| | Est | Robust | Robust Z | *p* value | Est | Robust | Robust Z | *p* value |
| Year | −1.25 | .09 | −13.43 | <.001 | −.07 | .14 | −.50 | .616 |
| log (GDP) | −20.74 | 1.64 | −12.61 | <.001 | −17.58 | 1.79 | −9.84 | <.001 |
| Gini Index | 2.07 | .30 | 6.85 | <.001 | 1.38 | .24 | 5.62 | <.001 |
| Expenditures on Education as a percentage of GDP | −7.51 | 2.07 | −3.62 | <.001 | −3.18 | 1.23 | −2.59 | .010 |

n = 142 nations and data from 1990–2012. Regression analysis used generalized estimating equations (GEE) with independence correlation structure approach used to account for year-to-year correlations and generate robust standard errors and *p* values.
GDP = per capita gross domestic product.

unable to examine subpopulations or regions within countries. Previous research [18,20] demonstrates that certain population subgroups and communities within countries are also more likely to suffer poverty and higher adolescent fertility. Owing to the small number of countries in some regions, we were unable to model data analyses by region.

Our analyses suffered from missing data—particularly for Gini and educational expenditures and particularly among low-income nations. However, as Gini changed by 4% over the 23 years studied and educational expenditures changed by less than 15%, our findings are unlikely to be influenced by differences between the values derived by imputation for missing data and the "true" values.

Adolescent fertility was not measured uniformly across countries: the ABR indicator is calculated using vital event reporting systems in wealthier nations but survey data in nations lacking vital event reporting systems. Adolescent pregnancy rates, while available for some countries, could not be examined in this global analysis, as abortion reporting and reliable data on abortions is not available for many nations [28]. Socioeconomic measures simplify the complexity of national economics. GDP does not include productivity at the household level nor does it capture data from the informal economy. The measure of educational expenditures, which calculates only government expenditures, does not incorporate private sector or household expenditures and therefore may underestimate expenditures in some countries.

Despite these limitations, it adds additional support to the growing body of evidence that suggests that narrowing income inequality gaps can improve the health and well-being of populations [24].

Taken together, given the sizeable associations between adolescent fertility and these socioeconomic indicators, these findings suggest that national initiatives to reduce adolescent fertility should include efforts to increase household income, to decrease economic disparities, and to increase educational spending. If poverty and income inequalities increase the risk for adolescent childbearing, then efforts to reduce poverty and inequalities may help lower adolescent fertility. Thus, investments in economic development (e.g., infrastructure, job creation) and poverty reduction (e.g., improvement and expansion of schooling, cash transfer strategies, microenterprise activities) have the potential to yield powerful health effects. Recent research has documented the impact of economic empowerment and cash transfer programs on health and social outcomes, including reproductive health [29]. Such programs help young people to complete their educational goals and to find new employment opportunities; these life opportunities can increase adolescent motivation to delay childbearing, to delay initiation of sex, and to use contraception. Our findings add new meaning to an old expression: "A bright future is the best contraceptive." [30]

## Funding Sources

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