Global differences in geography, religion and other societal factors are associated with sex differences in mortality from suicide: An ecological study of 182 countries

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Highlights

- Across all continents and socioeconomic classes, males die as a consequence of suicide more than females.
- Countries with predominant religions that hold highly forbidden views towards suicide showed lower suicide rates amongst both males and females.
- Advancement in socioeconomic factors has a favourable impact on female suicide rates but not males'.

Abstract

Background
Over 800,000 individuals die as a consequence of suicide annually, and almost two thirds of these deaths are in males. This analysis aimed to explore sex differences in global suicide rates with regards to geographic location, religion and other societal factors.

Methods
Data on sex-specific suicide rates were collated for 182 countries in 2015. The exposures of interest were geographical location, majority religion, life expectancy, total fertility rate (TFR), literacy percentage, gender development index and gross domestic product.

Results
Both continent and predominant religion were strongly associated with the male:female ratio for deaths from suicide (p<0.001 for both variables). The highest male:female suicide ratio was observed in the Americas with a median value of 4.0 (interquartile range IQR: 3.0 to 5.0) and the lowest gender suicide ratios were observed in Africa (2.7, IQR: 2.4 to 3.3) and Asia (2.7, IQR: 1.8 to 3.9). The predominantly Christian countries revealed the highest male:female suicide ratio (3.3, IQR: 2.7 to 4.4) whereas the predominantly Hindu countries revealed the lowest (1.3, IQR 1.3 to 3.8).
The following variables were all positively associated with male:female ratio of suicide mortality: Life expectancy (Spearman's correlation coefficient r=+0.21, p=0.004), GDP *per capita* (r=+0.26, p=0.003), literacy percentage (r=+0.46, p<0.0001), and Gender Development Index (r=+0.56, p<0.0001). TFR was negatively associated with sex suicide ratio (-0.30, p<0.0001).
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Conclusion
There are significant differences between male and female suicide rates across continents and cultures. Markers of societal development are associated with a higher proportion of male suicides compared to females.

Introduction
In 2012, over 800 000 individuals were estimated to have died as a consequence of suicide globally (1). Male sex is a risk factor for suicide, and this observation is generally consistent across a broad range of countries (1), although the relative quantitative differences in the male:female sex ratio varies between geographic locations. As different societies vary widely globally with regard to cultural factors such as religion, education, and female emancipation rates as well as the size of their economies, these are external factors that may explain some of the variance in the male:female suicide rates. While many of these cultural and macroeconomic factors are not in themselves amenable to intervention, understanding how societal factors may have a differential effect on male and females risk of suicide mortality may help design measures that can be used to reduce these events. The existing research on the impact of societal factors on the male:female ratio of mortality as a consequence of suicide is limited. Global data from 1999 demonstrated that countries with a predominance of aetheists had the highest male to female suicide ratio (3.5) as opposed to Hindu-predominant countries that demonstrated the lowest sex suicide ratio (1.3) (2). We hypothesised that as these factors influence the living environment, they could have differential impacts on the two sexes, modifying the relative risks of men dying as a consequence of suicide compared to females.

We have used an ecological study design to explore the impact of geography, religion, education, literacy, and indices of female equality with males in society on the male:female suicide ratio globally.

Methods
Study design
The study is an ecological, cross-section study of sex-stratified suicide rates in 182 countries around the world in 2015.

Primary outcome data collection
The primary outcome measure was the male:female suicide rate ratio. This was downloaded from the WHO Global Health Observatory data repository (3). Data from 182 countries were available on male and female suicide rates in 2015.

Exposure data collection
Countries were grouped based on the UN division for continents. For each country, the religious affiliation of the majority of the population, and not the country's official religion, was noted down. There were 7 main religious affiliations: Buddhism, Islam, Christianity, Hinduism, unaffiliated, folk religion, and Judaism. Since there was one country in each of folk religion and Judaism, these two religions were omitted from the comparative analysis of religion, leaving five categories for religion for analysis. Life expectancy (4), gross domestic product (GDP) at purchasing power parity (PPP) per capita (5–7), education reflected in the percentage of people aged 15 and above who can read and write over the total population (8), total fertility rate (9), and gender development index, a measure of gender inequality in 3 main domains-health, knowledge and living standards (10) using data from 2015.

Statistical analysis
Data management, statistical analysis used STATA statistical package version 15. As the male:female sex ratios were not normally distributed, a non-parametric statistical approach was used.

Results

Data on national male:female sex ratios of mortality rates from suicide were available for 182 countries in 2015.

Geography
There were significant differences in the male:female suicide rates across continents (p=0.0001, Kruskal-Wallis test) and these data are presented in Figure 1. The highest was in the Americas with a median value of 4.0 male:female suicides (interquartile range IQR: 3.0 to 5.00) and the lowest was in Africa and Asia with median values of 2.7 (IQR: 2.4 to 3.3) and 2.7 (IQR: 1.8 to 3.9), respectively.

Religion
There were significant differences in male:female suicide rates after stratification for the majority religion (p=0.001 Kruskal-Wallis test) as observed in Figure 2. The highest male:female suicide ratio was observed in the countries where Christianity was the predominant religion with a median value of 3.3 (IQR 2.7 to 4.4). The lowest male:female suicide ratio was observed in countries where Hinduism was the predominant religion, with a median value of 1.3 (IQR 1.3 to 3.8).

Life expectancy, per capita GDP (PPP), education, total fertility rate, and gender development index
The male:female suicide mortality ratio was positively associated with life expectancy, *per capita* GDP (PPP), education, and the gender development index (Figure 3). However, it was inversely associated with the total fertility rate (Figure 4).

Discussion
This is the first study to explore the association of cultural factors on male:female suicide rates globally. The results demonstrate that geographical location, predominant religion, national life expectancy, GDP *per capita*, literacy percentage, and Gender Development Index and total fertility rate are all significantly associated with sex suicide ratio.

Strengths and limitations of the analysis
The strength of the analysis is that it has used a global dataset to test the hypotheses of interest and as such represents the optimal ecological study design available. One important limitation is that individual countries can be expected to have locally developed systems of registering deaths and documenting the medically diagnosed cause that are likely to differ depending on resources available. As suicide can be considered a taboo or shameful event in some cultures, and hence the death certification could document an alternative cause of death that does not mention that fact that it was a consequence of suicide, this is a potential source of bias. If this measurement error is non-differential and impacts on males and females equally, then this would not be expected to bias our analysis as the under-reporting would not change the primary outcome measure of male:female sex mortality ratio from suicide. However, if it was differential and was present in one sex more than another, this could be expected to be a potential source of bias. However, for this to be a major problem in an analysis of 182 countries, it would need to be evident in a large number of the countries studied, which is unlikely.

The definition of majority religion is a necessary but imperfect measure of religion, as many countries are subdivided into regions which are often defined by religious populations, especially in countries that were previously colonised and had borders imposed upon them prior to independence. Our analysis uses the relative difference in mortality from suicide between males and females as the main outcome measure, and as a consequence gives no absolute quantitative assessment of the difference in numbers of deaths in males compared to females. Hence, the associations generated provide an indication of the relative risk of suicide mortality in males compared to females, but not the difference on absolute numbers or the public health impact. Many of the exposures in this analysis are related to developmental indices and hence co-linear.

As a consequence, we did not proceed to a multivariate regression analysis as this may give a misleading hierarchy of outcomes, particularly as there will be different degrees of measurement error for the exposures, which when combined together may give an erroneous overview of the relative importance of the exposures studied (11). Finally, it is important to note that ecological studies are unable to demonstrate causal associations, and as a consequence can be considered hypothesis generating. However, they are useful as studying societal exposures at the individual level can be challenging, and hence an ecological study is an appropriate methodological approach for the hypotheses that have been tested in this analysis.

Geographical location
Similarly to an earlier analysis by Varnick of data from 2008 (12), our data demonstrated that the highest male:female ratio was observed in the Americas, and the lowest were in Asia and Africa. The geographical comparisons are particularly heterogenous, as can be seen by the fact that the Americas contains countries such as the USA and Bolivia, which are very different in terms of culture and economy. However, the fact that the male:female suicide mortality ratio is lowest in Asia would be compatible with the relatively subservient role that women can be exposed to in Asian countries, which may increase their rates of suicide relative to males (13–15).

Predominent religion
Similar to geographical location, using the predominant religion to categorise a country generates data that needs to be interpreted with caution, as religion is but one facet of any society. Nonetheless, as religions can generate guidance that may be pertinent to suicide, this was considered an interesting societal measure to consider in the analysis. Those countries with Christianity as the predominant religion have the highest male:female suicide mortality ratio. It is not clear from our ecological data why this should be, although the sex-stratified rates suggest a possible protective effect on women as opposed to an increase in suicide mortality rates in males. Alternatively, Christianity may be a confounding factor that is associated with other societal and cultural infuences that explain these differences. These include the fact that Christianity is often associated with countries having a colonial history, that may lead to a variety of societal influences in addition to religion. The countries where Hinduism is the predominant religion has the lowest male:female suicide mortality ratio. These countries are India, Mauritius and Nepal where women do have a relatively unempowered role, and this may be reflected in their rates of suicide being closer to parity with the men's rates. However, there are only three countries in this grouping, which underlines the fact that drawing firm causal conclusions of associations from these data is not possible.

National life expectancy, GDP per capita, literacy and gender development index
There was a very significant association between national life expectancy and male:female suicide ratio, with life expectancy accounting for approximately 4% of the variance in this relation. This suggest that as the national wellbeing improves, it results in a widening of the relative risk of males dying from suicide compared to females. This differs with a prior analysis by Mayer where an inverse association was obsverved (16). However data were only available for 37 countries in this earlier analysis which used data from 1996, so the two results are not directly comparable, A similar sized association is seen with *per capita* GDP, and it is likely that these observations are related and hence co-linear to each other as economic development is one of the main drivers for an increase in life expectancy (17).

The observation that education as measured by the percentage of the population who can read and write in the population is strongly associated with the male:female suicide mortality supports the hypothesis that in countries where the population are more empowered by education, females are relatively less likely to die as a consequence of suicide; with this exposure variable accounting for approximately 16% of the variance in the data. Education provides individuals with more opportunities in life, and promotes higher female participation of labour force (FPLF); the higher the FPLF, the lower are the suicide rates as observed by Stack (18) and Chen et al (15). We thus

speculate that these may temper the risk of suicide mortality more in females compared to males. This is consistent with the positive association between gender development index (GDI) and male:female mortality ratio, which is strongly significant and accounts for 31% of the variance in the data. This is one of the most interesting results in our analysis, as it compares an exposure variable that incorporates a composite value for sex inequality that has three domains, health, knowledge and living standards. A value of 1 equals parity of females with males, and as can be seen in Figure 3, there is a clear positive association with the relative risk of mortality from suicide in males compared to females, that continues even when the GDI is higher than parity. This is consistent with the observation that gender equality as measured by gender equality index is associated with high male:female suicide mortality ratio (19).

Total fertility rate
Finally, total fertility rate is significantly associated with the male:female suicide mortality ratio, and as the number of children per woman decreases, the relative risk of suicide in females decreases compared to males. As fertility rate is associated with both economic development (20) and female education (17) and empowerment (17), this can be considered consistent with the other observations in this dataset.

Summary
This analysis of ecological data from 182 countries shows clear associations between geographical, economic and societal factors and the relative risk of suicide in males compared to females. While the male:female suicide mortality ratio is consistently higher than parity, demonstrating that males are more at risk of death from suicide, this is modified by cultural measures that may be considered proxies for societal development and female empowerment. The implication is that as societies become richer and more educated, males have a higher risk of dying as a consequence of suicide relative to females. These data are hypothesis generating and hopefully will contribute to the understanding the processes that drive this sex differential are essential to implement public health interventions to prevent deaths from suicide in the future.

Funding

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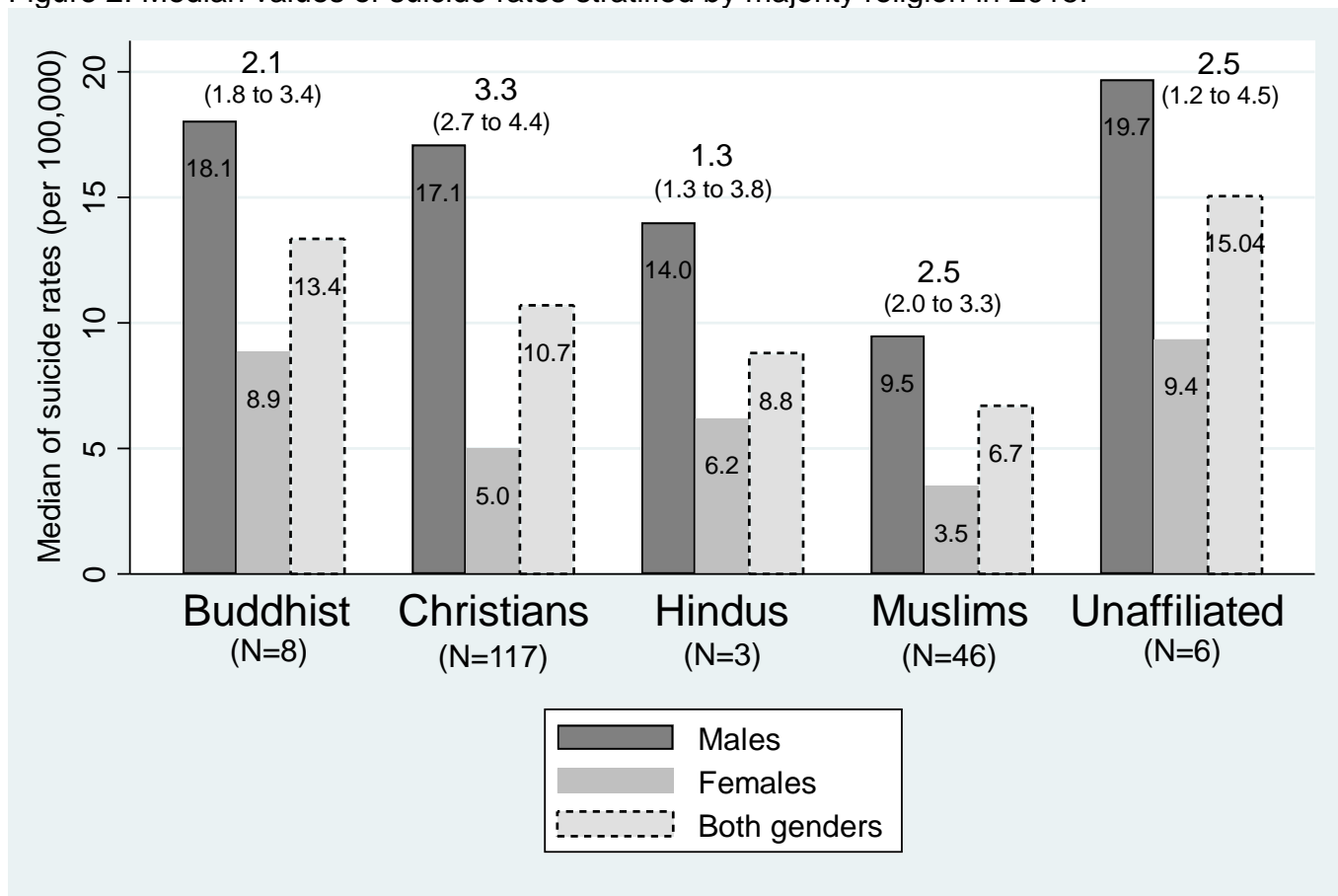Figure 1. Median values of suicide rates stratified by continent in 2015.
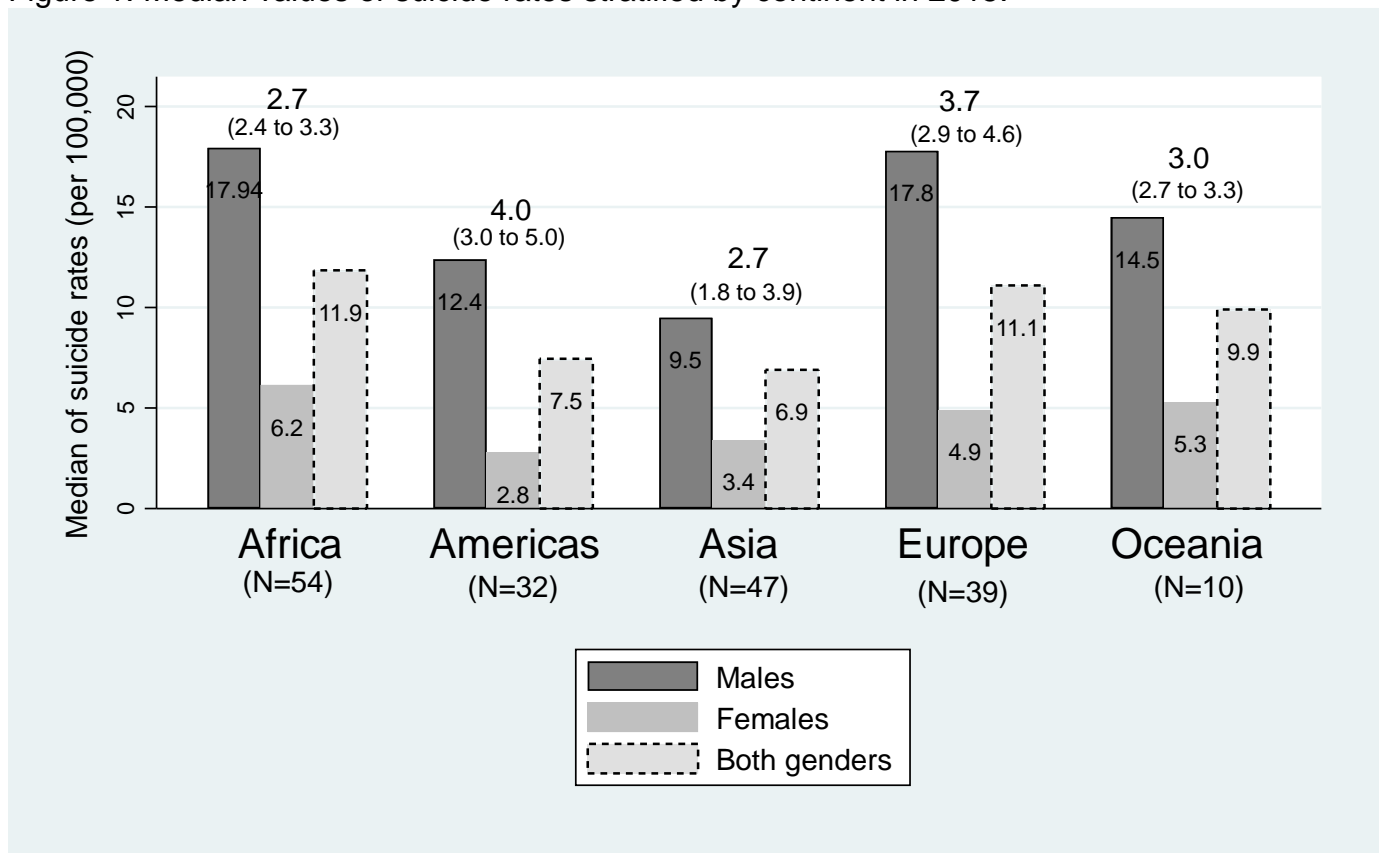
Note-Antarctica is a continent but does not host any countries.
Number above bars represents the median Male:Female suicide ratio (interquartile range)
N=number of countries

Figure 2. Median values of suicide rates stratified by majority religion in 2015.

Number above bars represents the median Male:Female suicide ratio (interquartile range)
N=number of countries

Table 1: Associations between the societal variables and suicide outcome variables.

Exposure Variables	Number of exposure observations	Male suicide rate	Female suicide rate	Male/Female suicide ratio
Life Expectancy (years)	182	**-0.28**	**-0.36**	**+0.21** (p=0.004)
GDP per capita (PPP) (current $)	182	-0.12	**-0.27**	**+ 0.26** (p=0.0003)
Education (literacy percentage)	149	-0.03	**-0.30**	**+0.46** (p<0.0001)
Total fertility rate (births per woman)	182	+0.12	**+0.27**	**-0.30** (p<0.0001)
GDI*	156	+0.11	**-0.23**	**+0.56** (p<0.0001)

Analysis using Spearman's correlation coefficient
Numbers in bold indicate statistical significance (p<0.05)
*GDI is a measure of the ratio of female to male Human Development Index (HDI) values. The closer the ratio is to one, the less is the gender disparity.

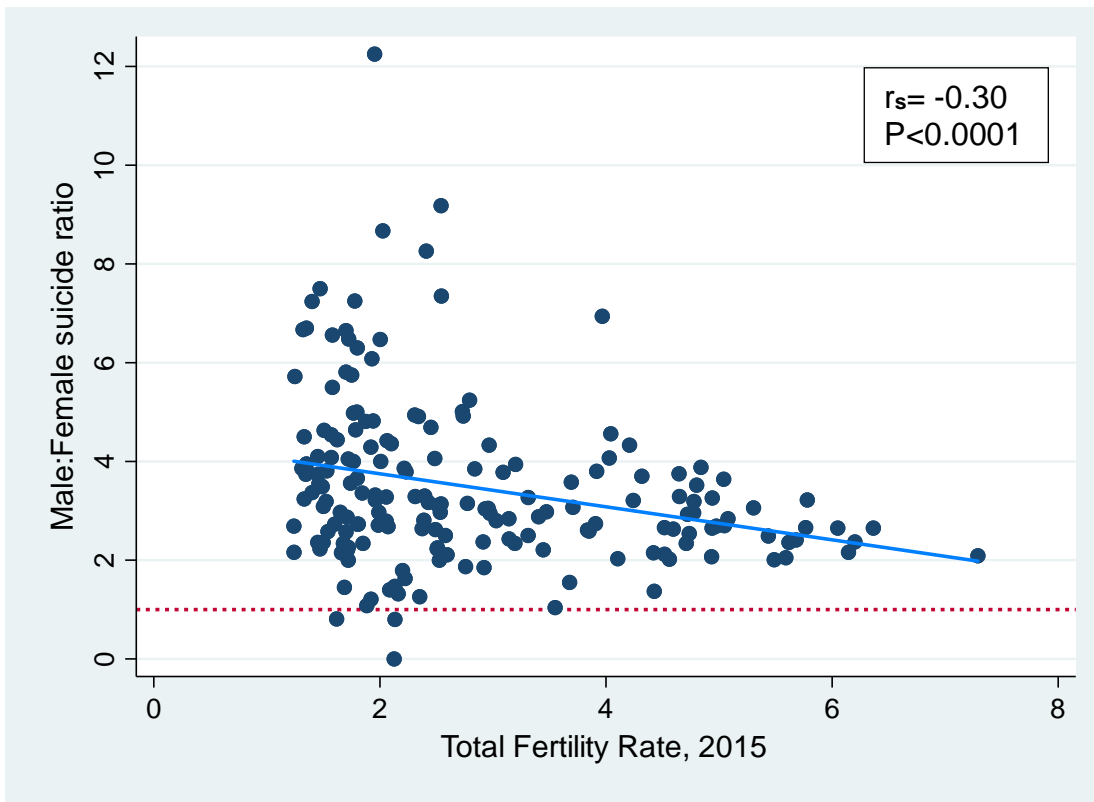Figure 3: The relationship between gender development index and the male:female suicide ratio in 2015.
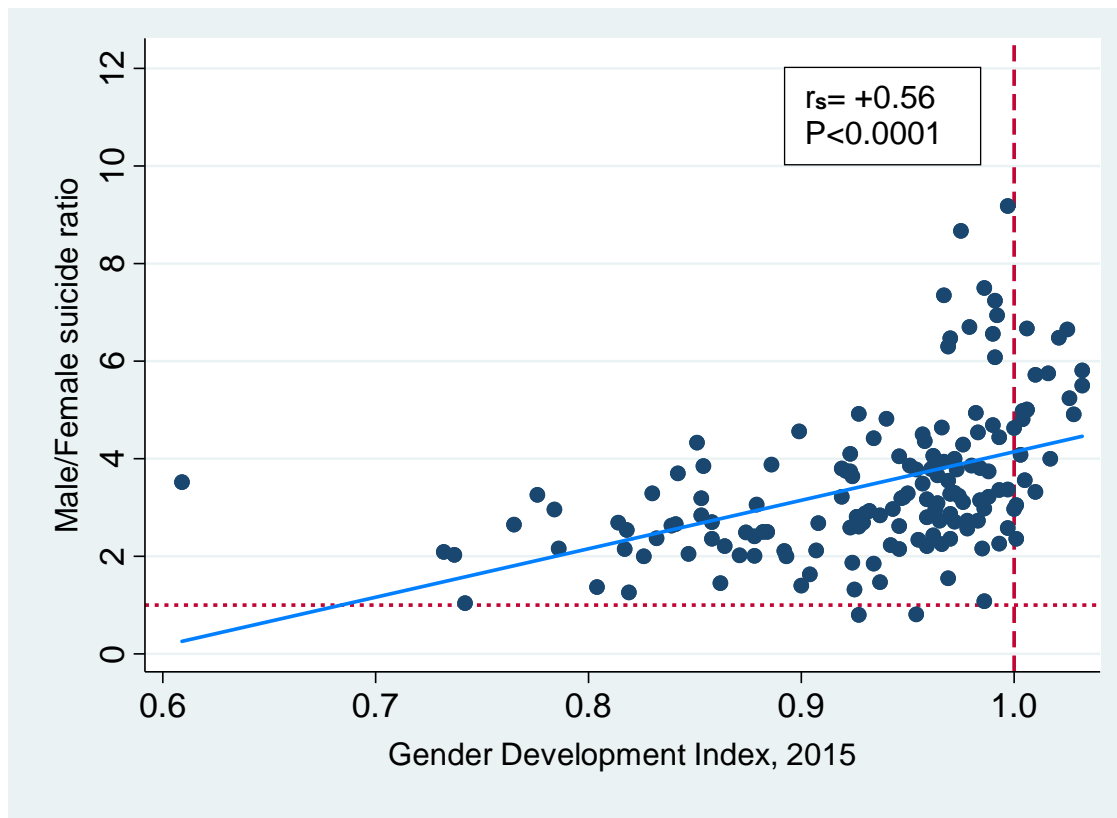
Straight line is line of best fit.
Horizontal dotted line where ratio of male:female suicide mortality rates = 1
Vertical dashed line where ratio of female:male HDI = 1
N=156

Figure 4: The association between total fertility rate and male:female suicide ratio in 2015.

Horizontal dotted line where ratio of male:female suicide mortality rates = 1
N=182