Global, regional, and national prevalence and disability-adjusted life-years for infertility in 195 countries and territories, 1990–2017: results from a global burden of disease study, 2017

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ABSTRACT

To provide comprehensive estimates of the global, regional, and national burden of infertility from 1990 to 2017, using findings from a 2017 study on the global burden of disease (GBD), we assessed the burden of infertility in 195 countries and territories from 1990 to 2017. DisMod-MR 2.1 is a Bayesian meta-regression method that estimates non-fatal outcomes using sparse and heterogeneous epidemiological data. Globally, the age-standardized prevalence rate of infertility increased by 0.370% per year for females and 0.291% per year for males from 1990 to 2017. Additionally, age-standardized disability-adjusted life-years (DALYs) of infertility increased by 0.396% per year for females and 0.293% per year for males during the observational period. An increasing trend to these burden estimates was observed throughout the all socio-demographic index (SDI) countries. Interestingly, we found that high SDI countries had the lowest level of prevalence and DALYs in both genders. However, the largest increasing trend was observed in high-SDI countries for females. By contrast, low-SDI countries had the largest increasing trend in males. Negative associations were observed between these burden estimates and the SDI level. The global disease burden of infertility has been increasing throughout the period from 1990 to 2017.

INTRODUCTION

Infertility is the inability to conceive within 1 year of unprotected intercourse, and it has been identified as a public health priority [1]. The Centers for Disease Control and Prevention of the United States emphasizes that infertility is more than a quality-of-life issue, with considerable public health consequences including psychological distress, social stigmatization, economic strain, and marital discord [2, 3]. Globally, infertility affects 15% of couples of reproductive age [4, 5]. A report from the 2006–2010 National Survey of Family Growth estimated that 6% of married females aged 15–44 years in the United States are infertile, and 12% have impaired fecundity, defined as the inability to conceive and carry a baby to term [6]. By contrast, among couples of reproductive age in China, the prevalence of infertility was 25% [7]. Furthermore, infertility is associated with increased risk of subsequent chronic health conditions such as cardiovascular disease [5].

A woman who is unable to bear a child is classified as having primary infertility. A woman who has previously conceived and successfully given birth yet is unable to do so subsequently is classified as having secondary infertility. Using survey data from 277 demographic and reproductive health surveys a study showed differences in the prevalence of primary and secondary infertility
between 1990 and 2010 in 190 countries and territories [8]. Some regions have a high prevalence of primary infertility, but a low prevalence of secondary infertility, such as North Africa and the Middle East, notably Morocco and Yemen. However, some areas have a high prevalence of secondary infertility but a low prevalence of primary infertility, such as Central and Eastern Europe and Central Asia. Additionally, several previous studies provided information regarding the prevalence of infertility according to sex. For example, the reported prevalence of infertility in Britain was 12.5% among females but 10.1% among males [9]. Of note, among these published studies, some focused only on females [10–12]. Others exclusively examined males registered at infertility clinics [13, 14]. As such, these studies were based on relatively small groups, unrepresentative of the larger population of infertile people [15, 16].

Infertility affects both sexes across the globe. On a global scale, accurate information regarding the burden of infertility is sorely lacking. Without accurate national and regional data on infertility, it is impossible to identify and comprehensively treat infertile patients. Therefore, in this systematic analysis, we assessed the global burden of infertility from 1990 to 2017 based on prevalence and disability-adjusted life-years (DALYs), and we assessed its relationship to the level of development, using the socio-demographic index (SDI; a composite indicator of income per person, years of education, and fertility).

RESULTS

Infertility prevalence

Globally, the age-standardized prevalence rate of female infertility increased by 14.962% from 1366.85 per 100,000 (95% UI: 988.34, 1819.86) in 1990 to 1571.35 per 100,000 (95% UI: 1115.30, 2121.94) in 2017, representing a shift of 0.370% per year (95% CI: 0.213, 0.527) (Figure 1). The age-standardized prevalence rate of male infertility increased by 8.224% from 710.19 per 100,000 (95% UI: 586.08, 848.94) in 1990 to 768.59 per 100,000 (95% UI: 623.20, 929.91) in 2017, with an increasing rate of 0.291% per year (95% CI: 0.241, 0.341) (Figure 2). Among those aged 15–44 years in 2017, the 35–39 age group had the highest prevalence rate, and the 15–19 age group had the lowest (Figures 3 and 4). When stratified by SDI quintiles, we observed an increasing trend in all SDI countries. Of note, although high-SDI countries had the lowest prevalence rate throughout the observational period among both genders (Figures 1 and 2), the high-SDI quintile had the largest increasing trend (annual percentage change (APC) = 0.766%) in females, with a 51.41% contribution rate to the total increasing trend (Supplementary Tables 1 and 2). By contrast, low-SDI countries had the largest increasing trend (APC = 0.385%) in males, with a 33.75% contribution rate to the total increasing trend (Supplementary Tables 1 and 2).

Among females, 14 regions showed an increasing trend among the 21 regions (Figure 1). The largest APC was observed in Andean Latin America (2.129%), followed by Tropical Latin America (1.504%) and North Africa and the Middle East (1.352%), which contributed 53.78% to the overall increasing trend (Supplementary Tables 1 and 2). Among males, increasing trends were observed in 16 of the 21 regions (Figure 2). The largest APC was detected in Andean Latin America (1.558%), followed by Tropical Latin America (0.926%) and Southeast Asia (0.660%), which contributed 47.39% to the overall increasing trend (Supplementary Tables 1 and 2).

We observed an increasing age-standardized prevalence of infertility among 89 and 136 countries and territories for females and males, respectively (Figures 5 and 6 and Supplementary Table 3). Among females, the top three countries and territories with increasing trends were Turkey (3.928%), Peru (3.597%), and Morocco (2.711%) (Figure 5 and Supplementary Table 3). By contrast, the top three countries and territories with decreasing trends were Zambia (-5.954%), Namibia (-5.943%), and Burundi (-3.112%) (Figure 5 and Supplementary Table 3). Among males, the top three countries and territories with increasing trends were Peru (2.265%), Morocco (1.676%), and Turkey (1.498%) (Figure 6 and Supplementary Table 3). By contrast, the top three countries and territories with decreasing trends were Zambia (-2.900%), Namibia (-2.181%), and Niger (-1.750%) (Figure 6 and Supplementary Table 3).

Infertility DALYs

Globally, age-standardized DALYs of female infertility increased by 15.834% from 7.599 per 100,000 (95% UI: 2.881, 15.974) in 1990 to 8.802 per 100,000 (95% UI: 3.328, 18.539) in 2017, at 0.396% per year (95% CI: 0.239, 0.552) (Figure 7). The age-standardized DALYs of male infertility increased by 8.843% from 4.20 per 100,000 (95% UI: 1.75, 8.75) in 1990 to 4.57 per 100,000 (95% UI: 1.89, 9.45) in 2017, at 0.293% per year (95% CI: 0.237, 0.349) (Figure 8). Among those aged 15–44 years in 2017, the 35–39 age group had the highest DALYs, and the 15–19 age group had the lowest (Figures 3 and 4). When stratified by SDI quintiles, we observed an increasing trend in all SDI countries (Figures 7 and 8). Of note, although high-SDI countries had the lowest prevalence rate throughout the observational period among both genders (Figures 1 and 2), the high-SDI
quintile had the largest increasing trend (annual percentage change (APC) = 0.714%) in females, with a 46.95% contribution rate to the total increasing trend (Supplementary Tables 4 and 5).

Among females, an increasing trend was observed in 14 of the 21 regions (Figure 7). Similar to prevalence, Andean Latin America (2.200%), Tropical Latin America (1.487%) and North Africa and the Middle East (1.273%) were the top three regions, contributing 54.34% to the overall increasing trend (Supplementary Tables 4 and 5). Among males, we observed an increasing trend in 16 of the 21 regions (Figure 8). The top three regions were Andean Latin America (1.436%), Tropical Latin America (0.871%), and Central Latin America (0.543%), contributing 46.97% to the overall increasing trend (Supplementary Tables 4 and 5).

We observed increasing age-standardized DALYs of infertility among 87 and 132 countries and territories for females and males, respectively (Figures 9 and 10, and Supplementary Table 6). Among females, the top three countries that increased were Turkey (3.667%), Peru (3.659%), and Morocco (2.772%) (Figure 9 and

![Figure 1. Trends in global disease burden of female infertility prevalence from 1990–2017.](image-url)
Supplementary Table 6). In contrast, the top three countries that decreased were Zambia (-5.842%), Namibia (-5.783%) and Burundi (-2.973%) (Figure 9 and Supplementary Table 6). Among males, the top three countries that increased were Peru (2.091%), Morocco (1.671%), and Turkey (1.326%) (Figure 10 and Supplementary Table 6). In contrast, the top three countries that decreased were Zambia (-2.863%), Namibia (-2.216%), and Niger (-1.843%) (Figure 10 and Supplementary Table 6).

Figure 2. Trends in global disease burden of male infertility prevalence from 1990–2017. (A) Trends in global disease burden of male infertility prevalence by socio-demographic index from 1990–2017; (B) Trends in global disease burden of male infertility prevalence by region from 1990–2017).
Global burden estimates of infertility in relation to SDI levels

We illustrated the associations between global burden estimates of infertility and the SDI levels for each of the 21 global burden of disease (GBD) regions for all individual years between 1990 and 2017 (Figures 11 and 12). General negative associations were observed between burden estimates and the SDI level. In brief, burden estimates tended to be stable when the SDI was limited to < 0.4. Subsequently, when the SDI was over 0.4, we observed negative associations between burden estimates and the SDI level. For Western Sub-Saharan Africa, we observed a U-shape association between...
prevalence and DALYs, and the SDI level. Similar patterns were observed in the Eastern and Central Sub-Saharan Africa.

**DISCUSSION**

To the best of our knowledge, this is the first study to provide a comprehensive assessment of the values and trends of burden estimates of infertility by sex in 195 countries and territories from 1990 to 2017 on the basis of GBD 2017 [17, 18]. The burden estimates of male and female infertility, as measured by prevalence and DALYs, increased globally between the observational period, and it increased in all countries regardless of the SDI. Of note, we observed the largest increasing burden estimates in low-SDI countries for males but in high-SDI countries for females. We expect that our findings will be invaluable to health professionals toward their

![Figure 4](image-url)
Figure 5. Global disease burden of female infertility prevalence in 195 countries and territories. (A) The percent change in age-standardized prevalence of female infertility between 1990 and 2017; (B) The estimated annual percentage change of female infertility age-standardized prevalence from 1990 to 2017).
Figure 6. Global disease burden of male infertility prevalence in 195 countries and territories. (A) The percent change in age-standardized prevalence of male infertility between 1990 and 2017; (B) The estimated annual percentage change of male infertility age-standardized prevalence from 1990 to 2017.)
efforts to reduce the burden of infertility in their respective regions.

This study demonstrated that the prevalence of female infertility is relatively higher than that of male infertility. However, limited studies have focused on infertility by gender. Nevertheless, our findings are consistent with these studies [9, 19]. Meanwhile, an etiological study that included community-based females and their husbands or male partners and

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Figure 7. Trends in global disease burden of female infertility disability-adjusted life-years from 1990–2017. (A) Trends in global disease burden of female infertility disability-adjusted life-years by socio-demographic index from 1990–2017; (B) Trends in global disease burden of female infertility disability-adjusted life-years by region from 1990–2017.)
Clinically-based patients showed that risk factors accounted for 65.9% of female infertility etiology, whereas this number was a mere 6.8% for male infertility [19]. It can be seen that the potential for infertility in females is greater than it is in males. The reason why the prevalence of female infertility is higher than male infertility might be attributed to two reasons. First, unlike female infertility, male infertility is not

Figure 8. Trends in global disease burden of male infertility disability-adjusted life-years from 1990–2017. (A). Trends in global disease burden of male infertility disability-adjusted life-years by socio-demographic index from 1990–2017; (B). Trends in global disease burden of male infertility disability-adjusted life-years by region from 1990–2017).
Figure 9. Global disease burden of female infertility disability-adjusted life-years in 195 countries and territories. (A). The percent change in age-standardized disability-adjusted life-years of female infertility between 1990 and 2017; (B) The estimated annual percentage change of female infertility age-standardized disability-adjusted life-years from 1990 to 2017.)
Figure 10. Global disease burden of male infertility disability-adjusted life-years in 195 countries and territories. (A). The percent change in age-standardized disability-adjusted life-years of male infertility between 1990 and 2017; (B). The estimated annual percentage change of male infertility age-standardized disability-adjusted life-years from 1990 to 2017.
Figure 11. Co-evolution of age-standardized burden estimates with SDI globally and for GBD regions for female infertility from 1990–2017. (A). Prevalence (B) DALYs. Colored lines show global and region values for age-standardized burden estimates rates. Each point in a line represents 1 year starting at 1990 and ending at 2017. The black line represents the average expected relationship between SDI and burden estimates rates for female infertility based on values from each region in the 1990–2017 estimation period. DALYs = disability-adjusted life-years. SDI = Socio-demographic Index.
Figure 12. Co-evolution of age-standardized burden estimates with SDI globally and for GBD regions for male infertility 1990–2017. (A) Prevalence (B) DALYs. Colored lines show global and region values for age-standardized burden estimates rates. Each point in a line represents 1 year starting at 1990 and ending at 2017. The black line represents the average expected relationship between SDI and burden estimates rates for male infertility based on values from each region in the 1990–2017 estimation period. DALYs = disability-adjusted life-years. SDI = Socio-demographic Index.
well reported in general, especially in countries where cultural differences and patriarchy prevent accurate statistics from being collected and compiled. Second, a study has shown that tubal factor infertility was the most common cause [19]. Reproductive health is of special importance to females, particularly during their reproductive years. Males also have reproductive health concerns and needs, but their general health is affected by their reproductive health to a lesser extent than in females [20]. Infertility caused by female reproductive health problems is more common. This helps to explain why the prevalence of infertility in females is higher than in males.

Among global infertile females and males aged 15–44 years from 1990 to 2017, the 35–39 age group had the highest prevalence and the 15–19 age group had the lowest. Researchers estimated the cumulative incidence of infertility for 1,037 males and females using a longitudinal birth cohort study in Dunedin, New Zealand. The results showed that the most pronounced incidence of infertility occurred during the mid- to late-30s [21]. In another study, researchers analyzed data from the infertility component of the 2009–2010 Canadian Community Health Survey for married and common-law couples with a female partner aged 18–44. Couples with lower parity (0 or 1 child) had significantly higher odds of being infertile when female partners were aged 35–44 years, compared to those 18–34 years old [22]. Another cross-sectional population survey showed that the age-adjusted odds of experiencing infertility were significantly higher among females who first gave birth at age 35 or older compared with those who did so before the age of 25 [9]. A similar, though slightly weaker, association was observed among males. These studies are very similar to our results. As far as we know, age at marriage can play an important role in causing infertility [23]. Over the past decades, conjugal unions have been delayed, resulting in couples starting to live together or getting married at an older age. This has led to a delay in childbearing, with females being older when first attempting pregnancy. A quantitative cross-sectional survey showed that a longer duration of infertility is associated with a significant decrease in the live-birth rate [24]. Meanwhile, females in their mid- to late-30s are nearing the end of their reproductive spans, when males may be experiencing an age-related decline in fertility. Because patients are older, the disease is more serious and the success rate of treatment is lower. Moreover, younger patients are prioritized for publicly funded infertility treatment in countries such as New Zealand [23, 24]. As such, older patients have less access to treatment.

We found that the largest increasing burden estimates were in low-SDI countries for males and in high-SDI countries for females. This may be attributed to the increasing rate of infertility detection, especially in males with low SDI levels, due to the gradual development of national economies. Of note, high-SDI countries had the lowest prevalence rate for both sex. To the best of our knowledge, disparities in infertility are likely due to differential distributions of factors such as education, socioeconomic status, health behavior, access to quality infertility services, and service-seeking behavior. Studies in Europe, North America, and Australia show that the large majority of research participants who experienced infertility but did not seek medical help. This is of concern, as are the marked inequalities in seeking help among those who are well qualified and employed in high-status jobs compared to those who are not [25–27]. A study has shown that the proportion of couples seeking medical care was 56% in developed countries and 51% in developing countries [28]. Although it is not possible to treat all these couples successfully, treatment will lead to a decline in infertility rates in economically developed regions. Thus, we found the lowest prevalence in areas with high-SDI countries. It is quite surprising that Datta et al. found that infertility was most common among females with a post-secondary degree and lowest among those with no academic qualifications, whereas no statistically significant association was observed among males in this regard. A large body of literature describes a trend among females in developed countries of delaying procreation, and it is expected that this changing tempo to fertility is becoming a global phenomenon [29]. Meanwhile, with overall improvements to the economy and changes to lifestyle, the number of overweight (and underweight) individuals is increasing, where obesity is an important factor leading to infertility [30]. Esmaeilzadeh et al. found in their study that infertile females had a 4.8-fold increased risk of obesity and an almost 3.8-fold increased risk of being overweight compared to fertile females [31].

Our investigation has several strengths. First, to the best of our knowledge, this is the first comprehensive overview of the epidemiological situation and trends regarding the female and male infertility burden around the world. Second, the GBD 2017 [17, 18] approach to estimating the prevalence of infertility is novel and can be repeated with relative efficiency. Our findings will be useful to resource allocation and health services planning for the growing number of patients with infertility. However, GBD 2017 [17, 18] methods have several limitations. First, data are absent or extremely sparse for some regions of the world. As such, the models we used to predict prevalence and DALYs might lead to unusual changes in segments of the data. We cannot ignore that the relatively low burden of infertility in developing countries is related to the under-diagnosis of the condition due to limited access to specialized medical care, imaging resources, and laboratory investigations. Until such information becomes available, however, we maintain
that the results from our model are valid. Second, the data lacks robust predictive covariates for infertility to aid in population-based risk assessments. GBD is actively seeking access to medical claims data in other countries to improve the accuracy of estimates for diseases such as infertility, for which every patient can be expected to be in contact with the health-care system if there are no major barriers to accessing care. Through our network of collaborators, we expect that future iterations of GBD will be able to add such sources from other countries. Third, there is no relevant data on risk factors of infertility in the GBD database. As such, we cannot compare the magnitude of the risk factors for infertility. Finally, reports on intentional injuries (especially self-harm and legal intervention) are subject to underreporting or even being covered up in many countries. Many of the countries involved in conflicts do not have a reliable health information system even in their preconflict states. We did not evaluate the indirect effects of collective violence (war) on total population. For example, Africa is affected by war, political and economic instability, resulting in population decrease [32, 33].

In summary, the burden estimates of infertility increased globally for both genders between 1990 and 2017. This report provides an integrated, contemporary understanding of the global infertility disease burden. Our findings can inform policymakers regarding the health care priority of infertility, and preventive and managerial interventions must be implemented to address the growing burden of infertility in these regions. More studies are needed to investigate the risk factors of infertility in order to carry out efficient preventive and managerial strategies to reduce the burden of this disease.

METHODS

Data sources

The Global Burden of Diseases, Injuries, and Risk Factors Study, 2017 (GBD 2017) employed a standardized analytical method that used all eligible sources to estimate epidemiological data, including prevalence and DALYs, for 354 causes by sex, age, and location from 1990 to 2017 [17]. It estimated all parameters for 195 countries and territories, nested in 21 regions. Details of the methodology of GBD studies and the main changes applied in GBD 2017 are provided in other articles (see supplementary file 1) [17, 18].

Modeling

For GBD 2017, the following case definitions were used for infertility: primary infertility was defined as existing in a couple who have not had a live birth, who wanted a child, and had been in a relationship for more than 5 years without using contraceptives. Secondary infertility was defined as existing in a couple who wanted a child and have been in a relationship for more than 5 years without using contraceptives since a previous live birth. Estimation was completed in three steps [17]. First, we estimated the total primary and secondary infertility in couples. This was accomplished by first quantifying the rate of infertility among married survey respondents and then quantifying how this married population related to the overall population. Second, we modeled the proportion of primary and secondary infertility due to female and male factors, respectively, to estimate four “envelopes” of infertility: male primary infertility, male secondary infertility, female primary infertility, and female secondary infertility. Third, we executed a “causal attribution” process to assign cases of each envelope to likely underlying causes and assigned the remainder to idiopathic infertility. Non-fatal modeling, using DisMod-MR 2.1, was performed to estimate the prevalence of infertility [34]. DisMod-MR 2.1 is a Bayesian meta-regression method that estimates non-fatal outcomes using sparse and heterogeneous epidemiological data. It also pools data from different sources, adjusts them for variations in study methods across sources, and enforces consistency between different epidemiological parameters. Binary study-level covariates were used to minimize the residual errors of the estimated prevalence and years lived with disability (YLD). Using mixed-effects nonlinear regression on all the available data at the global level, super-region Bayesian priors were generated; likewise, the super-region regression model was then used to generate regional Bayesian priors, and so on down the cascade [34, 35]. YLD were calculated by multiplying the prevalence of each sequela by its disability weight and adding the procedure-related morbidity associated with infertility treatment [34]. Years of life lost (YLL) due to infertility were calculated using normative global life expectancy. DALYs were calculated by summing the YLD and YLL [36].

Socio-demographic Index

The SDI is a summary measure that estimates a location’s position on a spectrum of development. The SDI and epidemiological transition SDI is a summary measure that places all GBD locations on a spectrum of socioeconomic development [37]. SDI, expressed on a scale of 0 to 1, is a summary measure that identifies where GBD locations sit on the spectrum of socioeconomic development [37]. The SDI is calculated based on the geometric mean of lag-distributed income, average years of schooling among populations aged 15 years or older, and total fertility rate. More details regarding the calculation of the SDI are provided in previous GBD publications [17, 18, 38]. All 195
countries and territories were then categorized into five regions in terms of the SDI; low, low-middle, middle, high-middle, and high. The cutoff values used to determine quintiles for analysis were then computed using country-level estimates of SDI for 2017, excluding countries with populations of less than 1 million. These quintiles are used to categorize and present GBD 2017 results on the basis of sociodemographic status. Additional details on and results from the SDI calculation are available in the supplementary file (Supplementary Table 1).

Statistical analysis

We ran DisMod-MR 2.1 models to estimate the proportion of primary and secondary infertility by sex, proportion of primary female infertility, proportion of secondary female infertility, proportion of primary male infertility, and proportion of secondary male infertility. We model sex-specific infertility as a proportion [17]. Prevalence was estimated for nine impairments, defined as sequelae of multiple causes for which better data were available to estimate the overall occurrence than for each underlying cause: Infertility and eight other diseases [17]. We assumed that infertility does not lead to mortality and, therefore, DALYs of infertility are equal to their YLD [34]. So we used the age-standardized prevalence rate and DALYs as well as the annual percentage change (APC) to quantify female and male infertility burden estimated trends [39]. Restricting the age range to 15 to 44 years and divided six 5-year age groups. All measures were age-standardized using the GBD standard population. The age-standardized rates (per 100,000 people) in accordance with a direct method were calculated by summing the products of age-specific rates and the number of individuals in the same age subgroup of the selected reference standard population and subsequently dividing the sum of standard population weights. The APC is a widely used measure of trends in an age-standardized rate over a specific time interval. A regression line was fitted to the natural logarithm of the rates. The APC and 95% confidential interval (CI) values can also be obtained from a linear regression model [40, 41]. We employed a generalized additive model with locally estimated scatterplot smoothing to the SDI to estimate the associations between SDI and the age-standardized prevalence rate and DALYs using GBD estimates from all national locations from 1990 to 2017 [42]. All statistical analyses were performed using SPSS (Version 23, SPSS Inc.) and the R program, Version 3.4.4 (ggplot2, readxl, dplyr), with P values <.001 considered significant. R program Version 3.4.4 was used to generate figures of the final estimates of prevalence and DALYs from data available from ghdx.healthdata.org/gbd-results-tool.

Abbreviations

DALYs: disability-adjusted life-years; SDI: sociodemographic index; GBD: global burden of disease; YLD: years of life lived with disability; YLL: years of life lost; APC: annual percentage change; CI: confidential interval; PC: percentage change.

AUTHORS CONTRIBUTION

Hui Sun and Ting-Ting Gong contributed equally to this work. Hui Sun, Ting-Ting Gong, Yu-Hong Zhao, and Qi-Jun Wu contributed to the study conception and design; Yu-Ting Jiang, Shuang Zhang contributed to acquisition, analysis, or interpretation of data; Hui Sun, Ting-Ting Gong, Yu-Hong Zhao, and Qi-Jun Wu contributed to the manuscript drafting and approval of the final version of the manuscript.

CONFLICTS OF INTEREST

All authors declare no conflicts of interest.

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REFERENCES

1. Centers for Disease Control and Prevention. National Public Health Action Plan for the Detection, Prevention, and Management of Infertility. Atlanta, Georgia: Centers for Disease Control and Prevention; June 2014.

2. Practice Committee of American Society for Reproductive Medicine. Definitions of infertility and recurrent pregnancy loss: a committee opinion. Fertil Steril. 2013; 99:63. https://doi.org/10.1016/j.fertnstert.2012.09.023 PMID:23095139

3. Zegers-Hochschild F, Adamson GD, de Mouzon J, Ishihara O, Mansour R, Nygren K, Sullivan E, Vanderpoel S, and International Committee for...
Monitoring Assisted Reproductive Technology, and World Health Organization. International Committee for Monitoring Assisted Reproductive Technology (ICMART) and the World Health Organization (WHO) revised glossary of ART terminology, 2009. Fertil Steril. 2009; 92:1520–24.
https://doi.org/10.1016/j.fertnstert.2009.09.009
PMID: 19828144

4. Gerrits T, Van Rooij F, Esho T, Ndegwaw W, Goossens J, Bilajbegovic A, Jansen A, Kioko B, Koppen L, Kemunto Migiro S, Mwenda S, Bos H. Infertility in the Global South: raising awareness and generating insights for policy and practice. Facts Views Vis Obgyn. 2017; 9:39–44.
https://doi.org/10.1007/978-3-030-24864-2_4
PMID: 28721183

5. Kurabayashi T, Mizunuma H, Kubota T, Hayashi K. Ovarian infertility is associated with cardiovascular disease risk factors in later life: A Japanese cross-sectional study. Maturitas. 2016; 83:33–39.
https://doi.org/10.1016/j.maturitas.2015.08.015
PMID: 26417693

6. Chandra A, Copen CE, Stephen EH. Infertility and impaired fecundity in the United States, 1982-2010: data from the National Survey of Family Growth. Natl Health Stat Rep. 2013; 67:1–18.
PMID: 24988820

7. Zhou Z, Zheng D, Wu H, Li R, Xu S, Kang Y, Cao Y, Chen X, Zhu Y, Xu S, Chen ZJ, Mol BW, Qiao J. Epidemiology of infertility in China: a population-based study. BJOG. 2018; 125:432–41.
https://doi.org/10.1111/1471-0528.14966
PMID: 29030908

8. Mascarenhas MN, Flaxman SR, Boerma T, Vanderpoel S, Stevens GA. National, regional, and global trends in infertility prevalence since 1990: a systematic analysis of 277 health surveys. PLoS Med. 2012; 9:e1001356.
https://doi.org/10.1371/journal.pmed.1001356
PMID: 23271957

9. Datta J, Palmer MJ, Tanton C, Gibson LJ, Jones KG, Macdowall W, Glacier A, Sonnenberg P, Field N, Mercer CH, Johnson AM, Wellings K. Prevalence of infertility and help seeking among 15 000 women and men. Hum Reprod. 2016; 31:2108–18.
https://doi.org/10.1093/humrep/dew123
PMID: 27365525

10. Sarac M, Koc I. PREVALENCE AND RISK FACTORS OF INFERTILITY IN TURKEY: EVIDENCE FROM DEMOGRAPHIC AND HEALTH SURVEYS, 1993-2013. J Biosoc Sci. 2018; 50:472–90.
https://doi.org/10.1017/S0021932017000244
PMID: 28641583

11. Mirzaei M, Namiranian N, Dehghani Firouzabadi R, Gholami S. The prevalence of infertility in 20-49 years women in Yazd, 2014-2015: A cross-sectional study. Int J Reprod Biomed (Yazd). 2018; 16:683–88.
PMID: 30775683

12. Jiao Y, Song X, Cai X. [A cross-sectional study of infertility prevalence and influencing factors in Uygur and Kazak women, Xinjiang Uygur autonomous region]. Zhonghua Liu Xing Bing Xue Za Zhi. 2015; 36:945–48.
PMID: 26814859

13. Karabulut S, Keskin i, Kutlu P, Delikara N, Atvar Ö, Öztürk M. Male infertility, azoozpermia and cryptozoospermia incidence among three infertility clinics in Turkey. Turk J Urol. 2018; 44:109–13.
https://doi.org/10.5152/tud.2018.59196
PMID: 29511578

14. Agarwal A, Mulgund A, Hamada A, Chyatte MR. A unique view on male infertility around the globe. Reprod Biol Endocrinol. 2015; 13:37.
https://doi.org/10.1186/s12958-015-0032-1
PMID: 25928197

15. Sepidarkish M, Almasi-Hashiani A, Shokri F, Vesali S, Karimi E, Omani Samani R. Prevalence of Infertility Problems among Iranian Infertile Patients Referred to Royan Institute. Int J Fertil Steril. 2016; 10:278–82.
PMID: 27695609

16. Meng Q, Ren A, Zhang L, Liu J, Li Z, Yang Y, Li R, Ma L. Incidence of infertility and risk factors of impaired fecundity among newly married couples in a Chinese population. Reprod Biomed Online. 2015; 30:92–100.
https://doi.org/10.1016/j.rbmo.2014.10.002
PMID: 25456165

17. James SL, Abate D, Abate KH, Abay SM, Abbafati C, Abbasi N, Abbastabar H, Abd-Allah F, Abdela J, Abdellaim A, Abdalhajj I, Abduklader RS, Abebo Z, et al, and GBD 2017 Disease and Injury Incidence and Prevalence Collaborators. Global, regional, and national incidence, prevalence, and years lived with disability for 354 diseases and injuries for 195 countries and territories, 1990-2017: A systematic analysis for the Global Burden of Disease Study 2017. Lancet. 2018; 392:1789–858.
https://doi.org/10.1016/S0140-6736(18)32279-7
PMID: 30496104

18. Vos T, Abajobir AA, Abate KH, Abbafati C, Abbas KM, Abd-Allah F, Abduklader RS, Abdule AM, Abebo TA, Abraha SF, Aboyans V, Abu-Raddad LJ, Ackerman IN, et al, and GBD 2016 Disease and Injury Incidence and Prevalence Collaborators. Global, regional, and national incidence, prevalence, and years lived with disability for 328 diseases and injuries for 195 countries, 1990-2016: a systematic analysis for the Global Burden of Disease Study 2016. Lancet. 2017;
19. Larsen U, Masenga G, Mlay J. Infertility in a community and clinic-based sample of couples in Moshi, Northern Tanzania. East Afr Med J. 2006; 83:10–17. https://doi.org/10.4314/eamj.v83i1.9355 PMID:16642745

20. Etuk SJ. Reproductive health: global infertility trend. Niger J Physiol Sci. 2009; 24:85–90. https://doi.org/10.4314/njps.v24i2.52920 PMID:20234744

21. van Roode T, Dickson NP, Righarts AA, Gillett WR. Cumulative incidence of infertility in a New Zealand birth cohort to age 38 by sex and the relationship with family formation. Fertil Steril. 2015; 103:1053–1058.e2. https://doi.org/10.1016/j.fertnstert.2014.12.121 PMID:25637476

22. Bushnik T, Cook JL, Yuzpe AA, Tough S, Collins J. Estimating the prevalence of infertility in Canada. Hum Reprod. 2012; 27:738–46. https://doi.org/10.1093/humrep/der465 PMID:22258658

23. Leke RJ, Oduma JA, Bassol-Mayagoitia S, Bacha AM, Grigor KM. Regional and geographical variations in infertility: effects of environmental, cultural, and socioeconomic factors. Environ Health Perspect. 1993 (Suppl 2); 101:73–80. https://doi.org/10.1289/ehp.93101s273 PMID:8243409

24. Swift BE, Liu KE. The effect of age, ethnicity, and level of education on fertility awareness and duration of infertility. J Obstet Gynaecol Can. 2014; 36:990–96. https://doi.org/10.1016/S1701-2163(15)30412-6 PMID:25574676

25. Chambers GM, Hoang VP, Illingworth PJ. Socioeconomic disparities in access to ART treatment and the differential impact of a policy that increased consumer costs. Hum Reprod. 2013; 28:3111–17. https://doi.org/10.1093/humrep/det302 PMID:23906901

26. Chandra A, Copen CE, Stephen EH. Infertility service use in the United States: data from the National Survey of Family Growth, 1982-2010. Natl Health Stat Report. 2014; 73:1–21. PMID:24467919

27. Terävä AN, Gissler M, Hemminki E, Luoto R. Infertility and the use of infertility treatments in Finland: prevalence and socio-demographic determinants 1992-2004. Eur J Obstet Gynecol Reprod Biol. 2008; 136:61–66. https://doi.org/10.1016/j.ejogrb.2007.05.009 PMID:17640794

28. Ledger WL. Demographics of infertility. Reprod Biomed Online. 2009 (Suppl 2); 18:11–14. https://doi.org/10.1016/S1472-6483(10)60442-7 PMID:19406025

29. Schmidt L, Sobotka T, Bentzen JG, Nyboe Andersen A, and ESHRE Reproduction and Society Task Force. Demographic and medical consequences of the postponement of parenthood. Hum Reprod Update. 2012; 18:29–43. https://doi.org/10.1093/humupd/dmr040 PMID:21989171

30. Cong J, Li P, Zheng L, Tan J. Prevalence and Risk Factors of Infertility at a Rural Site of Northern China. PLoS One. 2016; 11:e0155563. https://doi.org/10.1371/journal.pone.0155563 PMID:27177147

31. Esmaeilzadeh S, Delavar MA, Basirat Z, Shafi H. Physical activity and body mass index among women who have experienced infertility. Arch Med Sci. 2013; 9:499–505. https://doi.org/10.5114/aoms.2013.35342 PMID:23847673

32. Mars B, Burrows S, Hjelmeland H, Gunnell D. Suicidal behaviour across the African continent: a review of the literature. BMC Public Health. 2014; 14:606. https://doi.org/10.1186/1471-2458-14-606 PMID:24927746

33. GBD 2015 Eastern Mediterranean Region Intentional Injuries Collaborators. Intentional injuries in the Eastern Mediterranean Region, 1990-2015: findings from the Global Burden of Disease 2015 study. Int J Public Health. 2018 (Suppl 1); 63:39–46. https://doi.org/10.1007/s00038-017-1005-2 PMID:28776251

34. Vosoughi K, Stovner LJ, Steiner TJ, Moradi-Lakeh M, Fereshtehnejad SM, Farzadfar F, Heydarpour P, Malekzadeh R, Naghavi M, Sahaara MA, Sepanlou SG, Tehrani-Banihashemi A, Majdzadeh R, et al. The burden of headache disorders in the Eastern Mediterranean Region, 1990-2016: findings from the Global Burden of Disease study 2016. J Headache Pain. 2019; 20:40. https://doi.org/10.1186/s10194-019-0990-3 PMID:31023215

35. Hassan B, Ahmed R, Li B, Noor A, Hassan ZU. A comprehensive study capturing vision loss burden in Pakistan (1990-2025): Findings from the Global Burden of Disease (GBD) 2017 study. PLoS One. 2019; 14:e0216492. https://doi.org/10.1371/journal.pone.0216492 PMID:31050688

36. Puett C, Bulit A, Myatt M. Disability-adjusted life-years for severe acute malnutrition: implications of
alternative model specifications. Public Health Nutr. 2019; 22:2729–37.
https://doi.org/10.1017/S1368980019001393
PMID:31267885

37. Institute for Health Metrics and Evaluation (IHMI). Rethinking Development and Health: Findings from the Global Burden of Disease Study. Seattle, WA: IHME, 2016.
http://www.healthdata.org/sites/default/files/files/policy_report/GBD/2016/IHME_GBD2015_report.pdf

38. Wang H, Abajobir AA, Abate KH, Abbafati C, Abbas KM, Abd-Allah F, Abarde S, Abrahim HN, Abu-Raddad LJ, Abu-Rmeileh NM, Adegeji IA, Aidedoyin RA, Adetifa IM, et al, and GBD 2016 Mortality Collaborators. Global, regional, and national under-5 mortality, adult mortality, age-specific mortality, and life expectancy, 1970-2016: a systematic analysis for the Global Burden of Disease Study 2016. Lancet. 2017; 390:1084–150.
https://doi.org/10.1016/S0140-6736(17)31833-0
PMID:28919115

39. Hankey BF, Ries LA, Kosary CL, Feuer EJ, Merrill RM, Clegg LX, Edwards BK. Partitioning linear trends in age-adjusted rates. Cancer Causes Control. 2000; 11:31–35.

40. Liu Z, Jiang Y, Yuan H, Fang Q, Cai N, Suo C, Jin L, Zhang T, Chen X. The trends in incidence of primary liver cancer caused by specific etiologies: results from the Global Burden of Disease Study 2016 and implications for liver cancer prevention. J Hepatol. 2019; 70:674–83.
https://doi.org/10.1016/j.jhep.2018.12.001
PMID:30543829

41. Wu QJ, Vogtmann E, Zhang W, Xie L, Yang WS, Tan YT, Gao J, Xiang JB. Cancer incidence among adolescents and young adults in urban Shanghai, 1973-2005. PLoS One. 2012; 7:e42607.
https://doi.org/10.1371/journal.pone.0042607
PMID:22880052

42. Feigin VL, Nichols E, Alam T, Bannick MS, Beghi E, Blake N, Culpepper WJ, Dorsey ER, Elbaz A, Ellenbogen NG, Fisher JL, Fitzmaurice C, Giussani G, et al, and GBD 2016 Neurology Collaborators. Global, regional, and national burden of neurological disorders, 1990-2016: a systematic analysis for the Global Burden of Disease Study 2016. Lancet Neurol. 2019; 18:459–80.
https://doi.org/10.1016/S1474-4422(18)30499-X
PMID:30879893
GBD OVERVIEW

Geographic units of the analysis

The locations included in GBD 2017 have been arranged into a set of hierarchical categories composed of seven super-regions and a further nested set of 21 regions containing 195 countries and territories (Appendix Table 1). Subnational estimation in GBD 2017 includes Brazil, China, India, Indonesia, Japan, Kenya, Mexico, South Africa, Sweden, the United Kingdom, and the United States, and new subnational assessments at the administrative one level for Ethiopia, Iran, Norway, and Russia and by Maori ethnicity for New Zealand. For this publication, we present subnational estimates in figures only for all subnational countries with the exception of the new assessments which will be reported in separate publications. Combined, there are a total of 390 locations at the first subnational unit level. Included in subnational Level 1 locations are countries that have been subdivided into the first subnational level, such as states or provinces, for the GBD analysis; subnational Level 2 only applies to India, England, and Russia. For this paper we present data at the national and territory level.

Time period of the analysis

A complete set of cause-specific prevalence, and YLD numbers and rates were computed for the years 1990, 1995, 2000, 2005, 2010, and 2017. All GBD 2017 results and online data visualisations are available at http://vizhub.healthdata.org/gbd-compare1 with access to results for all GBD metrics.

Statement of GATHER compliance

This study complies with the Guidelines for Accurate and Transparent Health Estimates Reporting (GATHER) recommendations. We have documented the steps involved in our analytical procedures and detailed the data sources used in compliance with the GATHER.

The GATHER recommendations may be found here: http://gather-statement.org/

GBD results overview

The core summary results include years of life lost (YLLs), years lived with disability (YLDs), and disability-adjusted life-years (DALYs). The GHDx includes data for causes, risks, cause-risk attribution, aetiologies, and impairments.

Data input sources overview

GBD 2017 incorporated a large number and wide variety of input sources to estimate mortality, population, fertility, causes of death and illness, and risk factors for 195 countries and territories from 1990-2017. These input sources are accessible through an interactive citation tool available in the GHDx.

Users can retrieve citations for a specific GBD component, cause or risk, and geography by choosing from the available selection boxes. They can then view and access GHDx records for input sources and export a CSV file that includes the GHDx metadata, citations, and information about where the data were used in GBD. Additional metadata for each input source are available through the citation tool, as required by the GATHER statement.

Infertility Outcome estimation

Conceptually, the estimation effort is divided into eight major components: (1) compiling data sources through data identification and extraction; (2) data adjustment; (3) estimation of prevalence by cause and sequelae using DisMod-MR 2.1 or alternative modelling strategies for selected cause groups; (4) estimation by impairment; (5) severity distributions; (6) incorporation of disability weights; (7) comorbidity adjustment; and (8) the estimation of YLDs by sequelae and causes.

DATA SOURCES, IDENTIFICATION, AND EXTRACTION

Systematic reviews

For GBD 2017, we conducted literature reviews for 82 non-fatal causes and one impairment through February 2018. For other disease sequelae, only a small fraction of the existing data appears in the published literature and other sources predominate such as survey data, disease registers, notification data or hospital inpatient data. As was done in GBD 2016, data were systematically screened from household surveys archived in the Global Health Data Exchange (http://ghdx.healthdata.org/), including Demographic and Health Surveys, Multiple Indicator Cluster Surveys, Living Standards Measurement Surveys, and Reproductive Health Surveys.
Other national health surveys were identified based on survey series that had yielded usable data for past rounds of GBD, sources suggested to us by in-country collaborators, and surveys identified in major multinational survey data catalogs, such as the International Household Survey Network and the World Health Organization (WHO) Central Data Catalog, as well as through country Ministry of Health and Central Statistical Office websites. Case notifications reported to the WHO were updated through 2017. Citations for all data sources used for nonfatal estimation in GBD 2017 are provided in searchable form through a web tool (http://ghdx.healthdata.org/).

Survey data preparation

For GBD 2017, survey data for which we have access to the unit record data constitute a substantial part of the underlying data used in the estimation process. During extraction, we concentrate on demographic variables (such as location, sex, age), survey design variables (such as sampling strategy and sampling weights), and the variables used to define the population estimate (such as prevalence or a proportion) and a measure of uncertainty (standard error, confidence interval or sample size and number of cases).

Nonfatal disease registries

For GBD 2017 nonfatal estimation, disease registries were an important source for a select number of conditions such as cancers, end-stage renal disease, and congenital disorders.

Registry data is particularly key in the estimation of neoplasms given the increasing attention to noncommunicable diseases, particularly cancers, in low and middle-income areas of the world. The GHDx source tool (http://ghdx.healthdata.org/data-type/disease-registry) provides a comprehensive list of registry data used in GBD estimation processes.

Data adjustment

In addition to the corrections applied to claims and hospital data, a number of other adjustments were applied to extracted nonfatal sources in order to make the data more consistent and suitable for modelling. In this second step of nonfatal estimation, commonly applied adjustments included age-sex splitting, bias correction, adjustments for underreporting of notification data, and computing expected values of excess mortality. Age-sex splitting was commonly applied to literature data reported by age or sex but not by age and sex. For GBD 2017, we split all data reported in age groups with a width greater than 20 years, using age patterns from available survey microdata or regional patterns derived from an initial run of main modelling tool, DisMod-MR 2.1. We relied on the meta-regression component of DisMod-MR 2.1 for most of the bias correction of data for variations in study attributes such as case definitions and measurement method. DisMod-MR 2.1 calculates a single adjustment that is applied regardless of age, sex, or location. If enough data were available to differentiate these adjustments by age, sex, or location, or if detailed survey data were available to make more precise adjustments between different thresholds on a biochemical measure, we applied bias corrections to the data before entry into DisMod-MR 2.1. For instance, we crosswalked between 12 different case definitions with different thresholds of fasting plasma glucose or glycated hemoglobin levels for diabetes mellitus based on available survey data with individual records of the actual measurements. In another example, we corrected data on COPD from surveys applying different thresholds on spirometry measurements using studies that had reported on prevalence of COPD for the reference and alternative thresholds. As this relationship varied with age, age-specific correction factors were derived. The correction of notification data for underreporting relied on studies that had examined the gap between true incidence and notified cases.

IMPAIRMENT AND UNDERLYING CAUSE ESTIMATION

Impairments in GBD are conditions or specific domains of functional health loss which are spread across many GBD causes as sequelae and for which there are better data to estimate the occurrence of the overall impairment than for each sequela based on the underlying cause. Overall impairment prevalence was estimated using DisMod-MR 2.1. We constrained cause-specific estimates of impairments, as in the 19 causes of blindness, to sum to the total prevalence estimated for that impairment. Estimates were made separately for primary infertility (those unable to conceive), secondary infertility (those having trouble conceiving again), and whether the impairment affected men and/or women.

Disability weights

To compute YLDs for a particular health outcome in a given population, the number of people living with that outcome is multiplied by a disability weight that represents the magnitude of health loss associated with the outcome. Disability weights are measured on a scale from 0 to 1, with 0 implying a state that is equivalent to full health and 1 a state equivalent to death.
Disability weights used in GBD studies prior to GBD 2010 have been criticized for the method used (person trade-off), the small elite panel of international public health experts who determined the weights and the lack of consistency over time as the GBD cause list expanded and additional disability weights from a study in the Netherlands24 were added or others derived by ad-hoc methods.

**YLD computation, uncertainty, and residual YLDs**

For GBD 2017, we computed YLDs by sequela as prevalence multiplied by the disability weight for the health state associated with that sequela. The uncertainty ranges reported around YLDs incorporates uncertainty in prevalence and uncertainty in the disability weight. To do this, we take the 1,000 samples of comorbidity-corrected YLDs and 1,000 samples of the disability weight to generate 1,000 samples of the YLD distribution. We assume no correlation in the uncertainty in prevalence and disability weights. The 95% uncertainty interval is reported as the 25th and 975th values of the distribution. Uncertainty intervals for YLDs at different points in time (1990, 1995, 2000, 2005, 2010, and 2016) for a given disease or sequela are correlated because of the shared uncertainty in the disability weight. For this reason, changes in YLDs over time can be significant even if the uncertainty intervals of the two estimates of YLDs largely overlap as significance is determined by the uncertainty around the prevalence estimates.

**Socio-demographic Index (SDI) analysis and epidemiological transition**

The Socio-demographic Index (SDI) is a composite indicator of development status strongly correlated with health outcomes. In short, it is the geometric mean of 0 to 1 indices of total fertility rate under the age of 25 (TFU25), mean education for those aged 15 and older (EDU15+), and lag distributed income (LDI) per capita.

**Development of revised SDI indicator**

SDI was originally constructed for GBD 2015 using the Human Development Index (HDI) methodology, wherein a 0 to 1 index value was determined for each of the original three covariate inputs (total fertility rate in ages 15 to 49, EDU15+, and LDI per capita) using the observed minima and maxima over the estimation period to set the scales.

In response to feedback from collaborators and the evolution of the GBD, we have refined the indicator with each GBD cycle. For GBD 2017, in conjunction with our expanded estimation of age-specific fertility, we chose to replace the total fertility rate as one of the three component indices with the total fertility rate under 25 (TFU25). The TFU25 provides a better measure of womens status in society, as it focuses on ages where childbearing disrupts the pursuit of education and entrance into the workforce.

During GBD 2016 we moved from using relative index scales to absolute scales to enhance the stability of SDIs interpretation over time, as we noticed that the measure was highly sensitive to the addition of subnational units that tended to stretch the empirical minima and maxima. We selected the minima and maxima of the scales by examining the relationships each of the inputs had with life expectancy at birth and under-5 mortality and identifying points of limiting returns at both high and low values, if they occurred prior to theoretical limits (e.g., a TFU25 of 0).

Thus, an index score of 0 represents the minimum level of each covariate input past which selected health outcomes can get no worse, while an index score of 1 represents the maximum level of each covariate input past which selected health outcomes cease to improve. As a composite, a location with an SDI of 0 would have a theoretical minimum level of development relevant to these health outcomes, while a location with an SDI of 1 would have a theoretical maximum level of development relevant to these health outcomes.

The composite Socio-Demographic Index is the geometric mean of these three indices for a given location year. The cutoff values used to determine quintiles for analysis were then computed using country-level estimates of SDI for the year 2017.

The table below illustrates Socio-Demographic Index groupings by location, based on 2017 values

| Location Name                                         | 2017 SDI Index Value | SDI Quintile          |
|-------------------------------------------------------|----------------------|-----------------------|
| Global                                                | 0.652205351          |                       |
| Central Europe, Eastern Europe, and Central Asia       | 0.765735064          |                       |
| Central Asia                                          | 0.672778523          |                       |
| Armenia                                               | 0.702021479          | High-middle SDI       |

The table above illustrates Socio-Demographic Index groupings by location, based on 2017 values.
| Country                  | Index     | Development Level |
|-------------------------|-----------|-------------------|
| Azerbaijan              | 0.701169598 | High-middle SDI   |
| Georgia                 | 0.699719344 | High-middle SDI   |
| Kazakhstan              | 0.735474229 | High-middle SDI   |
| Kyrgyzstan              | 0.606646902 | Low-middle SDI    |
| Mongolia                | 0.661854015 | Middle SDI        |
| Tajikistan              | 0.522612209 | Low-middle SDI    |
| Turkmenistan            | 0.696418617 | Middle SDI        |
| Uzbekistan              | 0.629546531 | Middle SDI        |
| Central Europe          | 0.813976167 |                  |
| Albania                 | 0.684614242 | Middle SDI        |
| Bosnia and Herzegovina  | 0.712609905 | High-middle SDI   |
| Bulgaria                | 0.79173721 | High-middle SDI   |
| Croatia                 | 0.824844721 | High SDI          |
| Czech Republic          | 0.850980459 | High SDI          |
| Hungary                 | 0.816804322 | High-middle SDI   |
| Macedonia               | 0.75436361 | High-middle SDI   |
| Montenegro              | 0.788188778 | High-middle SDI   |
| Poland                  | 0.84377326 | High SDI          |
| Romania                 | 0.784193905 | High-middle SDI   |
| Serbia                  | 0.75179332 | High-middle SDI   |
| Slovakia                | 0.841690487 | High SDI          |
| Slovenia                | 0.860279598 | High SDI          |
| Eastern Europe          | 0.785420363 |                  |
| Belarus                 | 0.772665439 | High-middle SDI   |
| Estonia                 | 0.857709406 | High SDI          |
| Latvia                  | 0.825131484 | High SDI          |
| Lithuania               | 0.840877452 | High SDI          |
| Moldova                 | 0.675572758 | Middle SDI        |
| Russian Federation      | 0.791738063 | High-middle SDI   |
| Ukraine                 | 0.740061596 | High-middle SDI   |
| High-income             | 0.854428248 | High-middle SDI   |
| Australasia             | 0.868509969 |                  |
| Australia               | 0.873188291 | High SDI          |
| New Zealand             | 0.842273544 | High SDI          |
| High-income Asia Pacific| 0.86894981 |                  |
| Brunei                  | 0.856240565 | High SDI          |
| Japan                   | 0.865093512 | High SDI          |
| Aichi                   | 0.874998978 | High SDI          |
| Akita                   | 0.829009097 | High SDI          |
| Aomori                  | 0.825175188 | High SDI          |
| Chiba                   | 0.859238574 | High SDI          |
| Ehime                   | 0.838399264 | High SDI          |
| Fuku                   | 0.852281964 | High SDI          |
| Fukuoka                 | 0.855307883 | High SDI          |
| Fukushima               | 0.830930555 | High SDI          |
| Gifu                    | 0.84923591  | High SDI          |
| Region          | SDI   | Category          |
|----------------|-------|-------------------|
| Gunma          | 0.850963336 | High SDI         |
| Hiroshima      | 0.862595627 | High SDI         |
| Hokkaido       | 0.841522308 | High SDI         |
| Hyogo          | 0.859765235 | High SDI         |
| Ibaraki        | 0.850665189 | High SDI         |
| Ishikawa       | 0.856039392 | High SDI         |
| Iwate          | 0.825241842 | High SDI         |
| Kagawa         | 0.849935485 | High SDI         |
| Kagoshima      | 0.829680279 | High SDI         |
| Kanagawa       | 0.874939342 | High SDI         |
| Kochi          | 0.825446834 | High SDI         |
| Kumamoto       | 0.831536501 | High SDI         |
| Kyoto          | 0.87256007  | High SDI         |
| Mie            | 0.853567757 | High SDI         |
| Miyagi         | 0.850313137 | High SDI         |
| Miyazaki       | 0.823112655 | High SDI         |
| Nagano         | 0.851209245 | High SDI         |
| Nagasaki       | 0.826141869 | High SDI         |
| Nara           | 0.847998888 | High SDI         |
| Niigata        | 0.843300137 | High SDI         |
| Oita           | 0.845989117 | High SDI         |
| Okayama        | 0.855866898 | High SDI         |
| Okinawa        | 0.817915416 | High SDI         |
| Osaka          | 0.872366437 | High SDI         |
| Saga           | 0.833665065 | High SDI         |
| Saitama        | 0.8520121   | High SDI         |
| Shiga          | 0.870844353 | High SDI         |
| Shimane        | 0.831040466 | High SDI         |
| Shizuoka       | 0.858790953 | High SDI         |
| Tochigi        | 0.853264467 | High SDI         |
| Tokushima      | 0.845285    | High SDI         |
| Tokyo          | 0.924328028 | High SDI         |
| Tottori        | 0.83436659  | High SDI         |
| Toyama         | 0.859824207 | High SDI         |
| Wakayama       | 0.839775092 | High SDI         |
| Yamagata       | 0.831923683 | High SDI         |
| Yamaguchi      | 0.849441807 | High SDI         |
| Yamanashi      | 0.854296098 | High SDI         |
| South Korea    | 0.871955704 | High SDI         |
| Singapore      | 0.872215248 | High SDI         |
| High-income North America | 0.868169406 | High SDI         |
| Canada         | 0.882086227 | High SDI         |
| Greenland      | 0.760075292 | High-middle SDI  |
| United States  | 0.86662166  | High SDI         |
| Alabama        | 0.837233514 | High SDI         |
| Alaska         | 0.86060992  | High SDI         |
| State                | SDI         | Category |
|----------------------|-------------|----------|
| Arizona              | 0.845107314 | High SDI |
| Arkansas             | 0.826148933 | High SDI |
| California           | 0.872398094 | High SDI |
| Colorado             | 0.882128544 | High SDI |
| Connecticut          | 0.906486727 | High SDI |
| Delaware             | 0.873744053 | High SDI |
| District of Columbia | 0.890203139 | High SDI |
| Florida              | 0.863631092 | High SDI |
| Georgia              | 0.848426298 | High SDI |
| Hawaii               | 0.872290363 | High SDI |
| Idaho                | 0.840713155 | High SDI |
| Illinois             | 0.879386003 | High SDI |
| Indiana              | 0.84792909  | High SDI |
| Iowa                 | 0.8704793   | High SDI |
| Kansas               | 0.864464964 | High SDI |
| Kentucky             | 0.83130395  | High SDI |
| Louisiana            | 0.834894869 | High SDI |
| Maine                | 0.872309993 | High SDI |
| Maryland             | 0.895667105 | High SDI |
| Massachusetts        | 0.913307727 | High SDI |
| Michigan             | 0.867717003 | High SDI |
| Minnesota            | 0.892987345 | High SDI |
| Mississippi          | 0.818942009 | High SDI |
| Missouri             | 0.85325798  | High SDI |
| Montana              | 0.863383139 | High SDI |
| Nebraska             | 0.87308561  | High SDI |
| Nevada               | 0.847315003 | High SDI |
| New Hampshire        | 0.904304115 | High SDI |
| New Jersey           | 0.899124902 | High SDI |
| New Mexico           | 0.835274776 | High SDI |
| New York             | 0.893442339 | High SDI |
| North Carolina       | 0.84978326  | High SDI |
| North Dakota         | 0.879820384 | High SDI |
| Ohio                 | 0.858271211 | High SDI |
| Oklahoma             | 0.838181089 | High SDI |
| Oregon               | 0.870700326 | High SDI |
| Pennsylvania         | 0.878553277 | High SDI |
| Rhode Island         | 0.890036984 | High SDI |
| South Carolina       | 0.846024965 | High SDI |
| South Dakota         | 0.860188872 | High SDI |
| Tennessee            | 0.836985155 | High SDI |
| Texas                | 0.837777472 | High SDI |
| Utah                 | 0.855766922 | High SDI |
| Vermont              | 0.89559193  | High SDI |
| Virginia             | 0.885122306 | High SDI |
| Washington           | 0.88440099  | High SDI |
| Region                          | SDI             | Provisioning Level |
|--------------------------------|-----------------|--------------------|
| West Virginia                  | 0.824706332     | High SDI           |
| Wisconsin                      | 0.87773172      | High SDI           |
| Wyoming                        | 0.869345173     | High SDI           |
| Southern Latin America         | 0.720171023     |                    |
| Argentina                      | 0.710150584     | High-middle SDI    |
| Chile                          | 0.748081344     | High-middle SDI    |
| Uruguay                        | 0.706753401     | High-middle SDI    |
| Western Europe                 | 0.856820142     |                    |
| Andorra                        | 0.901838419     | High SDI           |
| Austria                        | 0.866029424     | High SDI           |
| Belgium                        | 0.886479194     | High SDI           |
| Cyprus                         | 0.86457342      | High SDI           |
| Denmark                        | 0.917864091     | High SDI           |
| Finland                        | 0.892872363     | High SDI           |
| France                         | 0.864667258     | High SDI           |
| Germany                        | 0.869902009     | High SDI           |
| Greece                         | 0.816993531     | High SDI           |
| Iceland                        | 0.907023083     | High SDI           |
| Ireland                        | 0.882181159     | High SDI           |
| Israel                         | 0.81594436      | High-middle SDI    |
| Italy                          | 0.843401161     | High SDI           |
| Luxembourg                     | 0.915748227     | High SDI           |
| Malta                          | 0.835898842     | High SDI           |
| Netherlands                    | 0.911855053     | High SDI           |
| Norway                         | 0.910905362     | High SDI           |
| Portugal                       | 0.777927627     | High-middle SDI    |
| Spain                          | 0.824616837     | High SDI           |
| Sweden                         | 0.883490275     | High SDI           |
| Stockholm                      | 0.914447593     | High SDI           |
| Sweden except Stockholm        | 0.872833379     | High SDI           |
| Switzerland                    | 0.888752501     | High SDI           |
| United Kingdom                 | 0.843093074     | High SDI           |
| England                        | 0.848869853     | High SDI           |
| East Midlands                  | 0.83007704      | High SDI           |
| East of England                | 0.840300066     | High SDI           |
| Greater London                 | 0.894369062     | High SDI           |
| North East England             | 0.820735615     | High SDI           |
| North West England             | 0.833664296     | High SDI           |
| South East England             | 0.856169812     | High SDI           |
| South West England             | 0.841270041     | High SDI           |
| West Midlands                  | 0.829368047     | High SDI           |
| Yorkshire and the Humber       | 0.829690925     | High SDI           |
| Northern Ireland               | 0.835352065     | High SDI           |
| Scotland                       | 0.805372811     | High SDI           |
| Wales                          | 0.805748561     | High SDI           |
| Latin America and Caribbean    | 0.639865451     |                    |
| Region                        | HDI       | Income Level          |
|-------------------------------|-----------|-----------------------|
| Andean Latin America          | 0.628313955 | Low-middle SDI       |
| Bolivia                       | 0.587409304 | Middle SDI           |
| Ecuador                       | 0.635566909 | Middle SDI           |
| Peru                          | 0.635787809 | Middle SDI           |
| Caribbean                     | 0.637604561 | Middle SDI           |
| Antigua and Barbuda           | 0.715130979 | High-middle SDI      |
| The Bahamas                   | 0.75556215  | High-middle SDI      |
| Barbados                      | 0.739423177 | High-middle SDI      |
| Belize                        | 0.602243591 | Low-middle SDI       |
| Bermuda                       | 0.80545317  | High-middle SDI      |
| Cuba                          | 0.687667664 | Middle SDI           |
| Dominica                      | 0.68658657  | Middle SDI           |
| Dominican Republic            | 0.592640504 | Low-middle SDI       |
| Grenada                       | 0.640418422 | Middle SDI           |
| Guyana                        | 0.583747015 | Low-middle SDI       |
| Haiti                         | 0.441665969 | Low SDI              |
| Jamaica                       | 0.678532504 | Middle SDI           |
| Puerto Rico                   | 0.812984477 | High-middle SDI      |
| Saint Lucia                   | 0.652614198 | Middle SDI           |
| Saint Vincent and the Grenadines | 0.608304473 | Middle SDI           |
| Suriname                      | 0.64099299  | Middle SDI           |
| Trinidad and Tobago           | 0.698405348 | Middle SDI           |
| Virgin Islands, U.S.          | 0.806568682 | High-middle SDI      |
| Central Latin America         | 0.623192305 | Middle SDI           |
| Colombia                      | 0.633692252 | Middle SDI           |
| Costa Rica                    | 0.662129526 | Middle SDI           |
| El Salvador                   | 0.59309467  | Low-middle SDI       |
| Guatemala                     | 0.524214498 | Low-middle SDI       |
| Honduras                      | 0.512339813 | Low-middle SDI       |
| Mexico                        | 0.628360997 | Middle SDI           |
| Aguascalientes                | 0.659089353 | Middle SDI           |
| Baja California               | 0.656785464 | Middle SDI           |
| Baja California Sur           | 0.658976353 | Middle SDI           |
| Campeche                      | 0.615914899 | Middle SDI           |
| Chiapas                       | 0.53276266  | Middle SDI           |
| Chihuahua                     | 0.638589391 | Middle SDI           |
| Coahuila                      | 0.645326148 | Middle SDI           |
| Colima                        | 0.65420353  | Middle SDI           |
| Durango                       | 0.623979236 | Middle SDI           |
| Guanajuato                    | 0.62129178  | Middle SDI           |
| Guerrero                      | 0.562442968 | Middle SDI           |
| Hidalgo                       | 0.587458446 | Middle SDI           |
| Jalisco                       | 0.648991934 | Middle SDI           |
| Mexico                        | 0.635428465 | Middle SDI           |
| Mexico City                   | 0.715772109 | Middle SDI           |
| Michoacan de Ocampo           | 0.58646838  | Middle SDI           |
| State              | Index     | SDI Type       |
|--------------------|-----------|----------------|
| Morelos            | 0.635471941 | Middle SDI    |
| Nayarit            | 0.620025881 | Middle SDI    |
| Nuevo Leon         | 0.677420872 | Middle SDI    |
| Oaxaca             | 0.560543467 | Middle SDI    |
| Puebla             | 0.584252823 | Middle SDI    |
| Queretaro          | 0.639127345 | Middle SDI    |
| Quintana Roo       | 0.626303085 | Middle SDI    |
| San Luis Potosi    | 0.620944629 | Middle SDI    |
| Sinaloa            | 0.648534168 | Middle SDI    |
| Sonora             | 0.650495685 | Middle SDI    |
| Tabasco            | 0.611463527 | Middle SDI    |
| Tamaulipas         | 0.647006129 | Middle SDI    |
| Tlaxcala           | 0.604441163 | Middle SDI    |
| Veracruz de Ignacio de la Llave | 0.591994 | Middle SDI |
| Yucatan            | 0.63033024  | Middle SDI    |
| Zacatecas          | 0.607654208 | Middle SDI    |
| Nicaragua          | 0.529616174 | Low-middle SDI|
| Panama             | 0.677043867 | Middle SDI    |
| Venezuela          | 0.655413104 | Middle SDI    |
| Tropical Latin America | 0.662126282 | Middle SDI    |
| Brazil             | 0.663312473 | Middle SDI    |
| Acre               | 0.601605235 | Low-middle SDI|
| Alagoas            | 0.555715012 | Low-middle SDI|
| Amapa              | 0.658517629 | Middle SDI    |
| Amazonas           | 0.629315711 | Middle SDI    |
| Bahia              | 0.591019766 | Low-middle SDI|
| Ceara              | 0.599501511 | Low-middle SDI|
| Distrito Federal   | 0.79189036  | High-middle SDI|
| Espirito Santo     | 0.676646695 | Middle SDI    |
| Goias              | 0.650146424 | Middle SDI    |
| Maranhao           | 0.507040138 | Low-middle SDI|
| Mato Grosso         | 0.662454796 | Middle SDI    |
| Mato Grosso do Sul | 0.650210546 | Middle SDI    |
| Minas Gerais       | 0.660795264 | Middle SDI    |
| Para               | 0.578664243 | Low-middle SDI|
| Paraiba            | 0.574462555 | Low-middle SDI|
| Parana             | 0.682436727 | Middle SDI    |
| Pernambuco         | 0.593552542 | Low-middle SDI|
| Piaui              | 0.551619925 | Low-middle SDI|
| Rio de Janeiro     | 0.708855843 | High-middle SDI|
| Rio Grande do Norte| 0.605294307 | Low-middle SDI|
| Rio Grande do Sul  | 0.6927427   | Middle SDI    |
| Rondonia           | 0.621702361 | Middle SDI    |
| Roraima            | 0.646354751 | Middle SDI    |
| Santa Catarina     | 0.702495682 | High-middle SDI|
| Sao Paulo          | 0.7200519   | High-middle SDI|
| Region                       | SDI          | Development Level       |
|------------------------------|--------------|-------------------------|
| Sergipe                      | 0.615627706  | Middle SDI              |
| Tocantins                    | 0.610879077  | Middle SDI              |
| Paraguay                     | 0.618769591  | Middle SDI              |
| North Africa and Middle East | 0.638603537  | Low SDI                 |
| Afghanistan                  | 0.290254968  | Low SDI                 |
| Algeria                      | 0.695849021  | Middle SDI              |
| Bahrain                      | 0.712258604  | High-middle SDI         |
| Egypt                        | 0.604307711  | Low-middle SDI          |
| Iran                         | 0.700086759  | High-middle SDI         |
| Iraq                         | 0.584823813  | Low-middle SDI          |
| Jordan                       | 0.696845045  | Middle SDI              |
| Kuwait                       | 0.785593198  | High-middle SDI         |
| Lebanon                      | 0.729621127  | High-middle SDI         |
| Libya                        | 0.760934217  | High-middle SDI         |
| Morocco                      | 0.579231309  | Low-middle SDI          |
| Palestine                    | 0.541353069  | Low-middle SDI          |
| Oman                         | 0.743531097  | High-middle SDI         |
| Qatar                        | 0.765715882  | High-middle SDI         |
| Saudi Arabia                 | 0.7790137    | High-middle SDI         |
| Sudan                        | 0.477915229  | Low-middle SDI          |
| Syria                        | 0.611084286  | Middle SDI              |
| Tunisia                      | 0.675428611  | Middle SDI              |
| Turkey                       | 0.729481001  | High-middle SDI         |
| United Arab Emirates         | 0.794722025  | High-middle SDI         |
| Yemen                        | 0.429504407  | Low SDI                 |
| South Asia                   | 0.533975763  | Low-middle SDI          |
| Bangladesh                   | 0.457988721  | Low-middle SDI          |
| Bhutan                       | 0.569907913  | Low-middle SDI          |
| India                        | 0.550242018  | Low-middle SDI          |
| Nepal                        | 0.428511471  | Low SDI                 |
| Pakistan                     | 0.492158484  | Low-middle SDI          |
| Southeast Asia, East Asia, and Oceania | 0.685403755 | Low-middle SDI          |
| East Asia                    | 0.708630758  | Low-middle SDI          |
| China                        | 0.707319288  | High-middle SDI         |
| North Korea                  | 0.537679957  | Low-middle SDI          |
| Taiwan                       | 0.86418562   | High SDI                |
| Oceania                      | 0.470985744  | Low-middle SDI          |
| American Samoa               | 0.701859796  | High-middle SDI         |
| Federated States of Micrones | 0.575251612  | Low-middle SDI          |
| Fiji                         | 0.641435501  | Middle SDI              |
| Guam                         | 0.794193119  | High-middle SDI         |
| Kiribati                     | 0.426768011  | Low SDI                 |
| Marshall Islands             | 0.550457832  | Low-middle SDI          |
| Northern Mariana Islands     | 0.75781722   | High-middle SDI         |
| Country                          | Value       | SDI Level          |
|---------------------------------|-------------|--------------------|
| Papua New Guinea                | 0.418998443 | Low SDI            |
| Samoa                           | 0.576375166 | Low-middle SDI     |
| Solomon Islands                 | 0.425018528 | Low SDI            |
| Tonga                           | 0.624951156 | Middle SDI         |
| Vanuatu                         | 0.475309121 | Low-middle SDI     |
| Southeast Asia                  | 0.640717246 |                   |
| Cambodia                        | 0.481619391 | Low-middle SDI     |
| Indonesia                       | 0.647611359 | Middle SDI         |
| Aceh                            | 0.640414411 | Middle SDI         |
| Bali                            | 0.646777358 | Middle SDI         |
| Bangka-Belitung Islands         | 0.637063919 | Middle SDI         |
| Banten                          | 0.636136405 | Middle SDI         |
| Bengkulu                        | 0.605588458 | Low-middle SDI     |
| Gorontalo                       | 0.556881893 | Low-middle SDI     |
| Jakarta                         | 0.795041917 | High-middle SDI    |
| Jambi                           | 0.640546524 | Middle SDI         |
| West Java                       | 0.635672599 | Middle SDI         |
| Central Java                    | 0.606724047 | Middle SDI         |
| East Java                       | 0.64169154  | Middle SDI         |
| West Kalimantan                 | 0.589201584 | Low-middle SDI     |
| South Kalimantan                | 0.623798672 | Middle SDI         |
| Central Kalimantan              | 0.641894718 | Middle SDI         |
| East Kalimantan                 | 0.746595227 | High-middle SDI    |
| North Kalimantan                | 0.755952734 | High-middle SDI    |
| Riau Islands                    | 0.727599596 | High-middle SDI    |
| Lampung                         | 0.616299987 | Middle SDI         |
| Maluku                          | 0.555610326 | Low-middle SDI     |
| North Maluku                    | 0.546157963 | Low-middle SDI     |
| West Nusa Tenggara             | 0.556566054 | Low-middle SDI     |
| East Nusa Tenggara             | 0.518912804 | Low-middle SDI     |
| Papua                           | 0.587862719 | Low-middle SDI     |
| West Papua                      | 0.683007739 | Middle SDI         |
| Riau                            | 0.713955299 | High-middle SDI    |
| West Sulawesi                   | 0.559336878 | Low-middle SDI     |
| South Sulawesi                  | 0.610967812 | Middle SDI         |
| Central Sulawesi                | 0.612199879 | Middle SDI         |
| Southeast Sulawesi              | 0.596388581 | Low-middle SDI     |
| North Sulawesi                  | 0.651649236 | Middle SDI         |
| West Sumatra                    | 0.640858055 | Middle SDI         |
| South Sumatra                   | 0.642344679 | Middle SDI         |
| North Sumatra                   | 0.653390877 | Middle SDI         |
| Yogyakarta                      | 0.65012062  | Middle SDI         |
| Laos                            | 0.518788871 | Low-middle SDI     |
| Malaysia                        | 0.759248836 | High-middle SDI    |
| Maldives                        | 0.655286841 | Middle SDI         |
| Mauritius                       | 0.720190502 | High-middle SDI    |
| Country                      | 2020 Gini Coefficient | Development Category          |
|------------------------------|-----------------------|-------------------------------|
| Myanmar                      | 0.555817824           | Low-middle SDI                |
| Philippines                  | 0.617174396           | Middle SDI                    |
| Sri Lanka                    | 0.679706328           | Middle SDI                    |
| Seychelles                   | 0.692334035           | Middle SDI                    |
| Thailand                     | 0.684276785           | Middle SDI                    |
| Timor-Leste                  | 0.504842989           | Low-middle SDI                |
| Vietnam                      | 0.606829222           | Middle SDI                    |
| Sub-Saharan Africa           | 0.445980066           |                                |
| Central Sub-Saharan Africa   | 0.45690943            |                                |
| Angola                       | 0.460535938           | Low-middle SDI                |
| Central African Republic     | 0.33449009            | Low SDI                       |
| Congo                        | 0.574129526           | Low-middle SDI                |
| Democratic Republic of the Congo | 0.364453165          | Low SDI                       |
| Equatorial Guinea            | 0.62522322            | Middle SDI                    |
| Gabon                        | 0.650559028           | Middle SDI                    |
| Eastern Sub-Saharan Africa   | 0.387060963           |                                |
| Burundi                      | 0.309705632           | Low SDI                       |
| Comoros                      | 0.434289553           | Low SDI                       |
| Djibouti                     | 0.484750347           | Low-middle SDI                |
| Eritrea                      | 0.408790995           | Low SDI                       |
| Ethiopia                     | 0.334181415           | Low SDI                       |
| Kenya                        | 0.499471993           | Low-middle SDI                |
| Madagascar                   | 0.330760552           | Low SDI                       |
| Malawi                       | 0.349345085           | Low SDI                       |
| Mozambique                   | 0.340470577           | Low SDI                       |
| Rwanda                       | 0.40744149            | Low SDI                       |
| Somalia                      | 0.234806633           | Low SDI                       |
| South Sudan                  | 0.274705978           | Low SDI                       |
| Tanzania                     | 0.412207128           | Low SDI                       |
| Uganda                       | 0.387738241           | Low SDI                       |
| Zambia                       | 0.472213354           | Low-middle SDI                |
| Southern Sub-Saharan Africa  | 0.639979771           |                                |
| Botswana                     | 0.663238118           | Middle SDI                    |
| Lesotho                      | 0.493356884           | Low-middle SDI                |
| Namibia                      | 0.615792035           | Middle SDI                    |
| South Africa                 | 0.676542582           | Middle SDI                    |
| Swaziland                    | 0.577699713           | Low-middle SDI                |
| Zimbabwe                     | 0.463195841           | Low-middle SDI                |
| Western Sub-Saharan Africa   | 0.441032713           |                                |
| Benin                        | 0.373374857           | Low SDI                       |
| Burkina Faso                 | 0.283938202           | Low SDI                       |
| Cameroon                     | 0.482039386           | Low-middle SDI                |
| Cape Verde                   | 0.549086441           | Low-middle SDI                |
| Chad                         | 0.252901641           | Low SDI                       |
| Cote d'Ivoire                | 0.412139874           | Low SDI                       |
| The Gambia                   | 0.404759628           | Low SDI                       |
INFERTILITY CASE DEFINITION AND MODELLING SUMMARY

For GBD 2017, the following case definitions were used for infertility:

1. Primary infertility is defined as a couple who have not had a livebirth, who wish a child, and have been in a union for more than five years without using contraceptives.

2. Secondary infertility is defined in a couple who wish a child and have been in a union for more than five years without using contraceptives since the last livebirth.

Estimation is completed in three steps. First, we estimate total primary (unable to have any child) and secondary (unable to have an additional child) infertility in couples. This is accomplished by first quantifying the rate of infertility among survey respondents who are married (the subset to whom such questions are directed) and then quantifying how the married population relates to the overall population. Second, we model which proportion of primary and secondary infertility is due to female and male factor, respectively, to estimate four “envelopes” of infertility: male primary infertility, male secondary infertility, female primary infertility, and female secondary infertility. Third, we execute a “causal artribution” process to assign cases of each envelope to likely underlying causes and assign the remainder to idiopathic infertility (ie, unknown causes).

Input data

Our primary data sources are population surveys. The datasets were last updated for GBD 2015. Data extraction included data for women in five-year age groups between 15 and 49 from population-based surveys including the Demographic and Health Surveys (DHS), World Fertility Surveys (WFS), Reproductive Health Surveys (RHS), Family and Fertility Survey (FFS), and others (EUR, NSF, PCD, PFM). Such surveys only ask fertility-related questions to married women. Even though only women are interviewed, we treated the responses as a proxy for the infertility of couples in unions because the questions are not structured in a way that it is possible to determine which partner is the cause of the couples’ inability to conceive a child.

The desire to have a child is the crucial determinant of whether a couple is labeled as infertile (ie, if no child is wanted, infertility is not present).

The combination of variables in surveys that were used to construct each of the four datasets (primary “impairment” and “exposure” and secondary “impairment” and “exposure”)are illustrated in the table below. As described below, overall primary and secondary infertility are estimated by multiplying prevalence among those with the “impairment” of infertility (married women who desire another child) by the prevalence of the “exposure” (being married for 5+ years, not using contraception for 5+ years).

| Model name | Infertility type | Numerator | Denominator |
|------------|-----------------|-----------|-------------|
| Primary    | Exposure to primary infertility | Married 5+ years; no contraception for 5+ years prior to survey; no previous births; desires a child. | Married 5+ years |
The second set of four datasets informed estimates of which component of primary and secondary infertility were due to female and male factors, respectively. To obtain data on the sex and cause breakdown for infertility, we systematically searched the literature in GBD 2010 using the following search string:

causes[Title/abstract] AND infertility[Title] NOT mouse NOT murine NOT rat NOT rodent

We received 626 hits from PubMed and excluded studies according to the following exclusion criteria:

1. studies not representative of the national population;
2. studies that provide no raw data,
3. studies that provide only estimates;
4. studies performed before 1970;
5. case studies or studies with sample size less than 50;
6. studies that provide no data on the sex of the partner responsible for infertility among couples.

The majority of excluded studies were excluded because of the latter criterion. In total, 15 studies were included in our analysis for the sex breakdown among infertile couples. Infertility among couples was reported as due to one of the following causes: male factor, female factor, both, or unknown. Couples with infertility due to both partners were allocated to both male factor and female factor, and couples with infertility of unknown cause were allocated to male and female factors based on the proportion observed in other couples in the study. We estimated the proportion of couples’ infertility due to male factors and female factors separately in DisMod-MR 2.1. The quantity modelled was the proportion of couples’ infertility due to each sex for each of primary and secondary infertility. The table below shows the dataset contents for these four models, each of which used the same set of sources.

| Proportion sex-specific primary and secondary infertility | Proportion |
|--------------------------------------------------------|------------|
| Site-years (total)                                      | 19         |
| Number of countries with data                          | 15         |
| Number of GBD regions with data (out of 21 regions)    | 8          |
| Number of GBD super-regions with data (out of 7 super-regions) | 6          |
| Number of GBD super-regions with data (out of 7 super-regions) | 6          |

**Modelling strategy**

For GBD 2017, we estimated the prevalence of primary and secondary infertility by sex and cause in three steps: 1) estimation of couples infertility [four DisMod-MR 2.1 models], 2) estimation of infertility by sex [four
DisMod-MR 2.1 models], and 3) causal attribution of infertility. We assumed zero infertility prior to age 15 or after age 50 years as fertility is not expected to be desired outside these age ranges in women; an assumption that was therefore carried over to men as well. All DisMod-MR 2.1 models were run as single parameter models. No study or country covariates were used in any models.

Estimation of couples’ infertility

To estimate the prevalence of primary and secondary infertility among couples, we first run four DisModMR 2.1 models to estimate the four parameters detailed above, prevalence of primary infertility (1), prevalence of primary infertility exposure (2), prevalence of secondary infertility (3), and prevalence of secondary infertility exposure (4). For prevalence of infertility (models 1 and 3), we tried using the natural log of the age-standardised death rate (lnASDR) of sexually transmitted infections (STIs), but it was not statistically significant so we did not use it in the final model. We did not use any study- or country-level covariates for these models. Next, we estimated primary and secondary couples’ infertility form DisMod-covariates for these models. Next, we estimated primary and secondary couples’ infertility form DisMod-MR 2.1 models by multiplying the estimates for prevalence of infertility among exposed women by the prevalence of exposure to infertility to obtain prevalence of infertility among all women and all men.

Estimation of infertility by sex

After running the four models estimating overall infertility, described above, we ran four DisMod-MR 2.1 models to estimate the proportion of primary and secondary infertility by sex, proportion of primary female infertility, proportion of secondary female infertility, proportion of primary male infertility, and proportion of secondary male infertility. We model sex-specific infertility as a proportion. Because infertility in some couples is attributable to both partners rather than just one, the sum of the proportions due to each partner is greater than one when both partners are infertile. When the sum of the proportions is lower than one, we scale it to be equal to one through custom code. Again, we tried using lnASDR of STIs as a covariate, but it was not statistically significant so we did not use it in the final model. We did not use any study- or country-level covariates for these models. We multiplied our prevalence of primary and secondary infertility derived in step 1 by the proportion due to male and female factors to estimate primary and secondary infertility by sex.

Causal attribution

There are seven identified causes of female infertility in the GBD 2017 cause list: pelvic inflammatory disease (PID) due to chlamydia, PID due to gonorrhoea, PID due to other sexually transmitted diseases, maternal sepsis, polycystic ovarian syndrome, endometriosis, and Turner syndrome. For each of these diseases, we determined the prevalence of infertility by a literature review of the probability of becoming infertile due to that disease. For STIs, we applied a proportion with infertility derived from Westrom and colleagues1 to incident cases of PID and used DisMod-MR 2.1 to calculate corresponding prevalence for each subsequent age group through the fertile years, assuming zero remission or excess mortality. For the others, we added all the disease-specific estimates of prevalence and assigned the remaining proportion to categories of “female primary infertility due to other causes” and “female secondary infertility due to other causes.” We assumed all infertility form Turner syndrome is primary infertility and all infertility following maternal sepsis is secondary infertility. The only recognized cause of male infertility in the GBD 2018 cause list is Klinefelter syndrome. We assigned all other male infertility to “male” infertility due to other causes.

Sequelae/disability weights

Every person with infertility was assumed to experience the health state as determined from the GBD disability weights survey. The lay descriptions of primary and secondary are listed below.

| Health state name | Health state description | Disability weight |
|-------------------|--------------------------|-------------------|
| Infertility, primary | This person wants to have a child and has a fertile partner, but the couple cannot conceive. | 0.008(0.003-0.015) |
| Infertility, secondary | This person has at least one child, and wants to have more children. The person has a fertile partner, but the couple cannot conceive. | 0.005(0.002-0.011) |

ESTIMATION PROCESS FOR DALYS

Computing DALYs

To estimate DALYs for GBD 2017, we started by estimating cause-specific mortality and non-fatal health
loss. For each year for which YLDs have been estimated (1990, 1995, 2000, 2007, 2010 and 2017), we compute DALYs by adding YLLs and YLDs for each age-sex-location. Uncertainty in YLLs was assumed to be independent of uncertainty in YLDs. We calculated 1,000 draws for DALYs by summing the first draw of the 1000 draws for YLLs and YLDs and then repeating for each subsequent draw. 95% uncertainty intervals (UI) were computed using the 25th and 975th ordered draw of the DALY uncertainty distribution. Please refer to the appendices of the GBD 2017 non-fatal capstone and cause of death capstone publications for information on how YLLs and YLDs were computed. We calculate DALYs as the sum of YLLs and YLDs for each cause, location, age group, sex, and year.
### Supplementary Tables

Supplementary Table 1. Trends in infertility age-standardized prevalence by sociodemographic index and region from 1990-2017.

| Characteristics                  | female                                             | male                                              |
|----------------------------------|----------------------------------------------------|---------------------------------------------------|
|                                  | Value | Rank | Value | 95% CI | Rank | Value | Rank | Value | 95% CI | Rank |
| Global                           | 14.962 | 0.370 | 0.213 | 0.527 | 8.224 | ↓ | 0.291 | 0.241 | 0.341 | 1   |
| Sociodemographic index           |        |      |       |        |        |      |       |        |        |      |
| Low                              | 5.818  | 5    | ↑      | 0.274 | -0.052 | 0.601 | 2    | ↑      | 9.893 | 2    | ↑    | 0.385 | 0.204 | 0.566 | 1    | ↑    |
| Low-middle                       | 9.856  | 2    | ↑      | 0.093 | -0.221 | 0.408 | 5    | ↑      | 10.907 | 1    | ↑    | 0.177 | -0.035 | 0.390 | 4    | ↑    |
| Middle                           | 9.529  | 3    | ↑      | 0.217 | 0.109 | 0.325 | 3    | ↑      | -4.936 | 3    | ↑    | 0.208 | 0.167 | 0.248 | 3    | ↑    |
| High-Middle                      | 6.205  | 4    | ↑      | 0.140 | 0.091 | 0.188 | 4    | ↑      | -2.395 | 1    | ↓    | 0.155 | 0.049 | 0.261 | 5    | ↑    |
| High                             | 25.152 | 1    | ↑      | 0.766 | 0.591 | 0.942 | 1    | ↑      | 3.241 | 4    | ↓    | 0.216 | 0.156 | 0.277 | 2    | ↑    |
| Region                           |        |      |       |        |        |      |       |        |        |      |      |      |      |      |      |      |
| Central Asia                     | 5.086  | 10   | ↑      | 0.170 | -0.052 | 0.393 | 11   | ↑      | -4.120 | 2    | ↓    | 0.174 | 0.062 | 0.287 | 12   | ↑    |
| East Asia                        | 5.005  | 11   | ↑      | 0.058 | -0.100 | 0.126 | 14   | ↑      | -2.545 | 5    | ↓    | 0.058 | -0.033 | 0.150 | 16   | ↑    |
| High-income Asia Pacific         | 2.924  | 12   | ↓      | -0.096 | -0.298 | 0.106 | 7    | ↓      | -3.870 | 3    | ↓    | 0.078 | -0.060 | 0.216 | 13   | ↑    |
| South Asia                       | 16.179 | 5    | ↑      | 0.538 | 0.208 | 0.869 | 8    | ↑      | 10.525 | 4    | ↑    | 0.313 | 0.120 | 0.506 | 8    | ↑    |
| Southeast Asia                   | 32.009 | 2    | ↑      | 0.965 | 0.603 | 1.329 | 4    | ↑      | 20.804 | 2    | ↑    | 0.660 | 0.412 | 0.909 | 3    | ↑    |
| Central Europe                   | 23.733 | 4    | ↑      | 0.591 | 0.420 | 0.763 | 5    | ↑      | -4.908 | 1    | ↓    | 0.217 | 0.023 | 0.412 | 11   | ↑    |
| Eastern Europe                   | 7.320  | 8    | ↑      | 0.138 | -0.012 | 0.289 | 12   | ↓      | -3.430 | 4    | ↓    | 0.230 | 0.104 | 0.356 | 10   | ↑    |
| Western Europe                   | 10.458 | 7    | ↑      | 0.324 | 0.199 | 0.449 | 9    | ↑      | 5.118  | 8    | ↑    | 0.314 | 0.201 | 0.427 | 7    | ↑    |
| Andean Latin America             | -7.515 | 3    | ↓      | 2.129 | 0.955 | 3.317 | 1    | ↑      | 20.128 | 3    | ↑    | 1.558 | 1.203 | 1.913 | 1    | ↑    |
| Central Latin America            | 44.729 | 1    | ↑      | 0.573 | 0.365 | 0.781 | 7    | ↓      | 28.420 | 1    | ↑    | 0.578 | 0.410 | 0.747 | 5    | ↑    |
| Southern Latin America           | -15.196 | 1 | ↓     | -0.723 | -0.880 | -0.565 | 2   | ↓     | 0.449 | 11   | ↑    | 0.058 | 0.042 | 0.075 | 15   | ↑    |
| Tropical Latin America           | 13.300 | 6    | ↑      | 1.504 | 0.928 | 2.083 | 2    | ↑      | 9.509  | 5    | ↑    | 0.926 | 0.654 | 1.199 | 2    | ↑    |
| High income                      | 6.195  | 9    | ↑      | -0.730 | -1.801 | 0.354 | 1    | ↓     | 0.521 | 10   | ↑    | -0.347 | -0.563 | -0.130 | 1    | ↓    |
| North America                    | -2.351 | 5    | ↓      | 0.585 | -0.012 | 1.187 | 6    | ↑      | 2.270  | 9    | ↑    | 0.539 | 0.143 | 0.937 | 6    | ↑    |
| Central Sub-Saharan Africa       | -0.756 | 7    | ↓      | -0.395 | -0.927 | 0.139 | 4    | ↓     | -1.539 | 8    | ↓    | -0.307 | -0.608 | -0.005 | 2    | ↓    |
| Eastern Sub-Saharan Africa       | -0.994 | 6    | ↓      | 0.262 | -0.013 | 0.538 | 10   | ↑     | -0.613 | 9    | ↓    | 0.267 | 0.096 | 0.439 | 9    | ↑    |
| Southern Sub-Saharan Africa      | 1.388  | 13   | ↑      | -0.662 | -1.182 | -0.140 | 3    | ↓     | 5.206 | 7    | ↑    | -0.304 | -0.639 | 0.033 | 3    | ↓    |
| Western Sub-Saharan Africa       | 30.368 | 3    | ↑      | 1.352 | 1.113 | 1.592 | 3    | ↑      | 9.027  | 6    | ↑    | 0.601 | 0.478 | 0.723 | 4    | ↑    |
| North Africa and Middle East     | -11.370 | 2 | ↓     | -0.222 | -0.361 | -0.084 | 6   | ↓     | 0.024 | 12   | ↑    | -0.003 | -0.015 | 0.010 | 5    | ↓    |
| Oceania                          | 0.949  | 14   | ↑      | 0.080 | 0.009 | 0.151 | 13   | ↑      | -2.232 | 7    | ↓    | 0.060 | -0.033 | 0.154 | 14   | ↑    |
| Australasia                      | -4.943 | 4    | ↓      | -0.239 | -0.306 | -0.171 | 5    | ↓     | -2.518 | 6    | ↓    | -0.111 | -0.147 | -0.074 | 4    | ↓    |

- **APC**: annual percent change
- **CI**: confidence interval
- **APC**: annual percent change

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Supplementary Table 2. The relative contributions of each geographical locations in trends of infertility prevalence from 1990-2017.

| Characteristics                     | female | Male |
|-------------------------------------|--------|------|
|                                     | Increasing trend | Decreasing trend | Increasing trend | Decreasing trend |
|                                     | Contribution rate (%) | Contribution rate (%) |                      |                   |
| Sociodemographic index              |         |      |         |                  |
| Low                                 | 18.37   | 33.75|         |                  |
| Low-middle                          | 6.26    | 15.52|         |                  |
| Middle                              | 14.58   | 18.20|         |                  |
| Middle-High                         | 9.39    | 13.60|         |                  |
| High                                | 51.41   | 18.93|         |                  |
| Region                              |         |      |         |                  |
| Central Asia                        | 1.84    | 2.63 |         |                  |
| Eastern Asia                        | 0.63    | 0.88 |         |                  |
| High-income Asia                    |         |      |         |                  |
| Pacific                             | 3.13    | 1.17 |         |                  |
| South Asia                          | 5.80    | 4.72 |         |                  |
| Southeast Asia                      | 10.41   | 9.95 |         |                  |
| Central Europe                      | 6.38    | 3.28 |         |                  |
| Eastern Europe                      | 1.49    | 3.47 |         |                  |
| Western Europe                      | 3.49    | 4.74 |         |                  |
| Andean Latin America                | 22.97   | 23.48|         |                  |
| Central Latin America               | 6.18    | 8.72 |         |                  |
| Southern Latin America              |         | 23.56| 0.88    |                  |
| Tropical Latin America              | 16.22   | 13.96|         |                  |
| North America                       | 23.79   | 32.40|         |                  |
| Central Sub-Saharan Africa          | 6.31    | 8.13 |         |                  |
| Eastern Sub-Saharan Africa          | 12.89   | 28.67|         |                  |
| Southern Sub-Saharan Africa         | 2.83    | 4.03 |         |                  |
| Western Sub-Saharan Africa          | 21.60   | 28.37|         |                  |
| North Africa and Middle East        | 14.59   | 9.05 |         |                  |
| Oceania                             | 7.25    | 0.24 |         |                  |
| Australasia                         | 0.86    | 0.91 |         |                  |
| Caribbean                           | 7.78    | 10.33|         |                  |

Please browse Full Text version to see the data of Supplementary Table 3.

Supplementary Table 3. Trends in infertility age-standardized prevalence rate of 195 countries and territories from 1990-2017.
## Supplementary Table 4. Trends in infertility age-standardized DALYs by sociodemographic index and region from 1990-2017.

| Characteristics                          | female |                  |                  | male |                  |                  |                |          |
|------------------------------------------|--------|-----------------|-----------------|------|-----------------|-----------------|----------------|------------|
|                                           | Value  | Rank | Percent Change | Value  | Rank | Percent Change | Value  | Rank | Percent Change |
| Global                                   | 15.834 | 0.396 | 0.239 | 0.552 | 8.843 | 0.293 | 0.237 | 0.349 |
| Sociodemographic index                   |        |          |               |       |          |               |       |      |               |
| Low                                      | 6.196  | 5 †     | 0.279 | -0.040 | 0.598 | 2 †     | 9.205 | 2 †     | 0.345 | 0.169 | 0.522 | 1 †     |
| Low-middle                               | 10.208 | 3 †     | 0.117 | -0.190 | 0.424 | 5 †     | 10.574 | 1 †     | 0.172 | -0.036 | 0.381 | 4 †     |
| Middle                                   | 10.591 | 2 †     | 0.245 | 0.139  | 0.350 | 3 †     | 6.118  | 3 †     | 0.226 | 0.192 | 0.260 | 2 †     |
| High-Middle                              | 6.919  | 4 †     | 0.167 | 0.119  | 0.215 | 4 †     | -0.970 | 1 †     | 0.175 | 0.084 | 0.266 | 3 †     |
| High                                     | 23.560 | 1 †     | 0.714 | 0.542  | 0.888 | 1 †     | 2.991  | 4 †     | 0.166 | 0.120 | 0.211 | 5 †     |
| Region                                   |        |          |               |       |          |               |       |      |               |
| Central Asia                             | 4.768  | 11 †    | 0.165 | -0.048 | 0.378 | 11 †    | -3.686 | 3 †     | 0.153 | 0.053 | 0.253 | 12 †    |
| East Asia                                | 5.714  | 9 †     | 0.076 | 0.011  | 0.141 | 13 †    | -1.584 | 6 †     | 0.063 | -0.023 | 0.149 | 13 †    |
| High-income Asia                         | 2.583  | 12 †    | -0.103 | -0.300 | 0.094 | 7 †     | -3.910 | 2 †     | 0.050 | -0.070 | 0.170 | 15 †    |
| Pacific                                  |        |          |               |       |          |               |       |      |               |
| South Asia                               | 16.036 | 5 †     | 0.512 | 0.195  | 0.829 | 8 †     | 10.057 | 4 †     | 0.275 | 0.087 | 0.463 | 8 †     |
| Southeast Asia                           | 29.602 | 2 †     | 0.873 | 0.540  | 1.208 | 4 †     | 17.639 | 3 †     | 0.524 | 0.308 | 0.742 | 6 †     |
| Central Europe                           | 22.728 | 4 †     | 0.566 | 0.402  | 0.729 | 7 †     | -4.065 | 1 †     | 0.201 | 0.029 | 0.374 | 11 †    |
| Eastern Europe                           | 6.717  | 8 †     | 0.134 | -0.008 | 0.276 | 12 †    | -2.646 | 5 †     | 0.205 | 0.100 | 0.310 | 10 †    |
| Western Europe                           | 10.123 | 7 †     | 0.322 | 0.201  | 0.443 | 9 †     | 5.270  | 7 †     | 0.298 | 0.198 | 0.398 | 7 †     |
| Andean Latin America                     | -5.284 | 3 †     | 2.200 | 1.039  | 3.375 | 1 †     | 19.162 | 2 †     | 1.436 | 1.116 | 1.757 | 1 †     |
| Central Latin America                    | -44.105| 1 †     | 0.574 | 0.369  | 0.779 | 6 †     | 26.378 | 1 †     | 0.543 | 0.388 | 0.697 | 3 †     |
| Southern Latin America                   | -14.713| 1 †     | -0.694 | -0.844 | -0.543 | 2 †     | 0.464  | 11 †    | 0.048 | 0.035 | 0.062 | 16 †    |
| Tropical Latin America                   | 11.425 | 6 †     | 1.487 | 0.896  | 2.081 | 2 †     | 7.382  | 6 †     | 0.871 | 0.596 | 1.147 | 2 †     |
| High income North America                | 5.578  | 10 †    | -0.751 | -1.814 | 0.324 | 1 †     | 0.597  | 10 †    | -0.373 | -0.613 | -0.132 | 1 †     |
| Central Sub-Saharan Africa               | -1.438 | 5 †     | 0.619 | 0.027  | 1.213 | 5 †     | 2.349  | 9 †     | 0.542 | 0.158 | 0.927 | 4 †     |
| Eastern Sub-Saharan Africa               | 0.038  | 15 †    | -0.357 | -0.875 | 0.164 | 4 †     | -0.827 | 8 †     | -0.281 | -0.578 | 0.017 | 3 †     |
| Southern Sub-Saharan Africa              | -1.425 | 6 †     | 0.260 | -0.013 | 0.535 | 10 †    | -0.744 | 9 †     | 0.268 | 0.098 | 0.439 | 9 †     |
| Western Sub-Saharan Africa               | 1.834  | 13 †    | -0.635 | -1.160 | -0.107 | 3 †     | 4.740  | 8 †     | -0.311 | -0.652 | 0.031 | 2 †     |
| North Africa and Middle East             | 27.877 | 3 †     | 1.273 | 1.034  | 1.512 | 3 †     | 7.706  | 5 †     | 0.532 | 0.414 | 0.649 | 5 †     |
| Oceania                                  | -10.388| 2 †     | -0.207 | -0.331 | -0.083 | 6 †     | -0.052 | 10 †    | -0.008 | -0.019 | 0.003 | 5 †     |
| Australasia                              | 1.019  | 14 †    | 0.067 | 0.002  | 0.132 | 14 †    | -1.536 | 7 †     | 0.057 | -0.017 | 0.131 | 14 †    |
| Caribbean                                | -4.886 | 4 †     | -0.225 | -0.287 | -0.163 | 5 †     | -2.901 | 4 †     | -0.111 | -0.145 | -0.076 | 4 †     |

a: percent change.  
b: annual percent change  
c: confidence interval
Supplementary Table 5: The relative contributions of each geographical locations in trends of infertility DALYs from 1990-2017.

| Characteristics | female          | Male          |
|-----------------|-----------------|---------------|
|                 | Increasing trend | Decreasing trend |
|                 | Contribution rate (%) | Contribution rate (%) | Increasing trend | Decreasing trend |
| Sociodemographic index | | | | | |
| Low             | 18.31           | 31.83         | | | |
| Low-middle      | 7.68            | 15.89         | | | |
| Middle          | 16.08           | 20.85         | | | |
| Middle-High     | 10.99           | 16.16         | | | |
| High            | 46.95           | 15.27         | | | |
| Region          |                 |               | | | |
| Central Asia    | 1.81            | 2.52          | | | |
| Eastern Asia    | 0.84            | 1.04          | | | |
| High-income Asia Pacific | 3.47 | 0.82 | | | |
| South Asia      | 5.61            | 4.53          | | | |
| Southeast Asia  | 9.57            | 8.64          | | | |
| Central Europe  | 6.20            | 3.32          | | | |
| Eastern Europe  | 1.47            | 3.38          | | | |
| Western Europe  | 3.53            | 4.91          | | | |
| Andean Latin America | 24.11 | 23.67 | | | |
| Central Latin America | 6.29 | 8.94 | | | |
| Southern Latin America | 23.34 | 0.80 | | | |
| Tropical Latin America | 16.29 | 14.36 | | | |
| North America   |                 |               | | | |
| Central Sub-Saharan Africa | 25.27 | 34.42 | | | |
| Africa          | 6.78            | 8.93          | | | |
| Eastern Sub-Saharan Africa | 12.01 | 25.92 | | | |
| Southern Sub-Saharan Africa | 2.85 | 4.42 | | | |
| Western Sub-Saharan Africa | 21.36 | 28.72 | | | |
| North Africa and Middle East | 13.94 | 8.76 | | | |
| Oceania         | 6.98            | 0.75          | | | |
| Australasia     | 0.73            | 0.94          | | | |
| Caribbean       | 7.57            | 10.20         | | | |

Please browse Full Text version to see the data of Supplementary Table 6.

Supplementary Table 6. Trends in infertility age-standardized DALYs of 195 countries and territories from 1990-2017.