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A Women's Rights-Based Approach to Reducing Child Mortality: Data from 193 Countries Show that Gender Equality does Affect Under-five Child Mortality

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Abstract

Objectives Mother's health and wellbeing significantly affects child health. Women's autonomy can improve healthcare-seeking behaviour, utilisation of healthcare services, and planned pregnancy, thereby improving child health. The global under-five mortality rate (U5MR) has seen the fastest decline in the past two decades, but the influence of gender equality on child mortality remains unaddressed. A strategic approach addressing gender equality is needed to reduce the U5MR further. The study aimed to identify and investigate the association between indicators of gender equality and U5MR using a human rights-based approach.

Methods We analysed open-source secondary data from international agencies comprising 521 gender-sensitive variables for 193 countries. Nine variables were included for the final Structural Equation Model based on the theoretical model. Model 1 consisted of 193 countries, and Model 2 comprised a subgroup analysis of 11 variables for 158 countries. Gender equality was a latent variable, and the U5MR was the outcome variable.

Results Gender equality was significantly associated with U5MR (Z = − 7.47, 95% CI = − 754.67 to − 440.98, $p < 0{\cdot}001$, n = 193 for Model 1, and Z = − 7.71, 95% CI = − 808.26 to − 480.72, $p < 0{\cdot}001$, n = 158 for Model 2). Female education, women's waged and salaried employment, women as employers, and women's representation in leadership and parliament enhanced gender equality, whereas the prevalence of child marriage and intimate partner violence (IPV) negatively affected gender equality. Improvement in gender equality significantly reduced U5MR.

Conclusions for practice Improving women's economic, educational, and social position and increasing female representation in higher leadership and policymaking positions is the key to reducing child mortality. Notably, eliminating child marriage and IPV is the key to achieving gender equality and is needed at the forefront of national policies. Gender equality can significantly improve women's reproductive autonomy, a critical factor in improving healthcare utilisation for women and their children.

Keywords Gender equality · Equity · Violence against women · Under five child mortality · Human rights based approach · Women's health

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Significance

What is already known about this topic? Mother's autonomy and well-being can influence child's health. However, there is a substantial gap in understanding which components of women's wellbeing, especially from a gender equality lens, can affect child's health.

What this study adds? Women's education, their waged and salaried employment, women employers, female representation in leadership roles and parliament, child marriage and intimate partner violence are significantly associated with gender equality. Gender equality is associated with under-five child mortality.

Background

A child's death is a traumatic experience for a family. The grief of losing a child is an agonising event that may cause long-term negative consequences to the mother's health and wellbeing (Raitio et al., 2015). The global under-five mortality rate (U5MR) was 42.5 per 1000 live births in 2015, translating to approximately 16,000 deaths per day, which is half of what it was in 1990 (You et al., 2015). However, the non-medical causes of the U5MR remained unaccounted for in the global statistics. Non-medical reasons of U5MR, such as armed conflicts, natural disasters, economic crises, political instability, repression due to abuse, domestic violence, feticides, and infanticides, affected the lives of millions of children during the past two decades. From 1995 to 2015, in Africa alone, more than 200,000 under-five child deaths were attributed to armed conflicts (Wagner et al., 2018). In 2016, female infanticide was responsible for 1.5 million deaths annually in more than 11 countries (ACHR, 2016). Moreover, female children are not given the same amount of care and attention to nutrition and health needs by parents in countries with strong son-bias, thereby affecting their long-term health (ACHR, 2016). Unintended pregnancy is another non-medical risk significantly associated with child mortality (Gipson et al., 2008). Poor antenatal care, lower breastfeeding practices and attention to nutritional needs are some of the potential effects of unintended pregnancies that directly affect child health (Gipson et al., 2008).

Medical causes accounted for 5.9 million under-five child deaths in 2015 (UN-IGME, 2015). More than 48 per cent of these deaths were caused by preterm birth complications, intrapartum related complications, pneumonia and diarrhoea, while vaccine-preventable diseases and other medical causes contributed to 2.2 million child deaths after the period of infancy (Liu et al., 2015). If the current U5MR remains steady or even reduces a little, a projected 68.8–94.4 million children are estimated to die due to medical and non-medical causes between 2016 and 2030 (You et al., 2015). To achieve the sustainable development goal (SDG) U5MR target of 25 per 1000 births, 47 countries have to accelerate their efforts, and the remaining countries need to continue allocating resources to reduce or maintain their efforts of reducing U5MR (UN-IGME, 2015). Most under-five child deaths due to medical causes can be prevented by minimising risks, improving nutrition and hygiene, breastfeeding, and vaccination coverage (Were et al., 2015). However, prevention of non-medical causes require a multi-systemic approach that also includes effective family planning policies (Were et al., 2015). Investing in family planning could reduce unintended pregnancies, which account for 40 per cent of pregnancies globally (Sedgh et al., 2014; Starbird et al., 2016). Contraception can prevent more than 85 million unintended pregnancies and avert more than seven million under-five deaths (Sedgh et al., 2014; Starbird et al., 2016). However, in 2014, more than 225 million women had an unmet need for contraception (Starbird et al., 2016). Despite clear evidence about life-saving interventions such as contraception and vaccination, reducing child mortality remains challenging. Several life-saving interventions primarily depend on the mother's perception, knowledge, attitude, and, most importantly, autonomy towards her child's health care needs. Moreover, maternal autonomy is strongly associated with child healthcare utilisation (Malhotra et al., 2012). Maternal autonomy can be achieved if there is an improvement in women's education and employment status, which are key factors to improving gender equality (Malhotra et al., 2012; Senarath & Gunawardena, 2009). Hence, it is necessary to view child mortality through the lens of women's rights, maternal wellbeing and, specifically, gender equality.

Few studies have highlighted the significance of the indicators of gender equality, such as mother's education, paid employment, intimate partner violence (IPV), and autonomy as important determinants associated with child mortality and morbidity (Abir et al., 2015; Emenike et al., 2008). The United Nations Development Programme (UNDP) developed a Gender Inequality Index (GII) using five significant indicators: secondary education attainment, representation of women in parliament, labour force participation of women, maternal mortality ratio (MMR), and adolescent fertility rate (UNDP, 2016). Brinda et al. found a positive association between GII and U5MR in 138 countries (Brinda et al., 2015). Similarly, Iqbal et al. also established that GII is significantly associated with the female U5MR than the male U5MR in 195 countries (Iqbal et al., 2018). However, both these studies have some significant limitations. The GII itself does not capture the most crucial aspects of gender equality, particularly gender-based violence (GBV), such as intimate and non-IPV or physical, emotional and sexual violence. GBV negatively affects

birth outcomes, breastfeeding practices, contraception use for planned pregnancy and U5MR (Emenike et al., 2008; Maxwell et al., 2015; Meiksin et al., 2015; Okenwa et al., 2011; Wallenborn et al., 2018). Given gender-based violence (GBV) is the most influential domain, it cannot be excluded from any literature that discusses gender equality. Therefore, GII may not be the appropriate index for measuring gender equality. Moreover, the discourse on gender equality has been constructed around multiple viewpoints, including differing theoretical definitions and understandings of its magnitude. Human development should be considered from a human rights and capabilities approach, rather than welfare or economy-only approach, as it prioritises choice, opportunities and selection, and demands equality (Sen, 2005). The human rights-based paradigm has been mentioned in the literature to offer strategies and tools to address root causes of mortality that are concerned with discrimination, accessibility to healthcare services, and issues caused due to deprivations of human rights (Khosla et al., 2017; Sen, 2005; Yamin, 2013). The women's rights framework further elaborates the critical aspects needed to improve maternal and child health by addressing gender equality (UN, 2014). However, there is a need to investigate the implications of gender equality on child mortality. Despite several attempts to define and measure gender equality, the multi-dimensional nature of its indicators has posed a challenge to investigating the effects of gender equality in the health domain. There is also a need to fill the knowledge gaps on the impact of gender equality on child mortality (Bagade et al., 2019). Analysing all available gender-sensitive variables to understand the association between the mother's wellbeing and the child's health through an explicit gender equality lens can help fill the gap in the literature and provide an evidence base for governments and policymakers. Thus, this study aimed to determine the association between a range of indicators of gender equality and under-five child mortality.

Methods

Study Design

The study was a population-level study of open-source data from 2000 to 2017, reported by international agencies for 193 countries.

Data Sources

Free and open access datasets were accessed from January 2018 to October 2018 from the United Nations Statistics Division (UNSD), United Nations Educational, Scientific and Cultural Organization (UNESCO), International Labour Organization (ILO), Inter-Parliamentary Union (IPU), the World Bank, and the UNDP (ILO, 2017; IPU, 2017; UIS-UNESCO, 2017; UNDP, 2017; UNSD-UNdata, 2019; WorldBank, 2017). The metadata was downloadable and accessible for public use under the Creative Commons Attribution 4·0 (CC-BY 4·0) international license (CreativeCommons, 2018). The UNSD and World Bank datasets contain extensive information on several gender-sensitive indicators. Data from ILO, UNESCO, UNDP, and IPU were checked for consistency and accuracy with the UNSD and the World Bank websites. The included variables, their definitions, and the related data source/s are in the supplementary material.

Selection Criteria

Conceptual Framework

We have developed a theoretical, conceptual framework describing the potential association between different factors of gender equality and U5MR (illustrated in Fig. 1). The framework was constructed using the existing literature. The matrix contains micro- to macro-level factors such as female education, paid employment, representation in leadership and parliament, and GBV related to gender equality and have previously affected U5MR. Education, paid employment, participation in leadership and parliament, and a reduction in GBV and child marriage can help to improve autonomy and, thereby, the motivation to use healthcare services and contraception (Bagade et al., 2019; Boyle et al., 2006; Malhotra et al., 2012; Nour, 2009; Senarath & Gunawardena, 2009). Education can increase awareness about self-care, self-worth, and self-awareness and help women reciprocate proactively to healthcare-related issues and messages (Boyle et al., 2006; Song & Burgard, 2011). As a result, women can become inclined to take early healthcare decisions (Malhotra et al., 2012; Senarath & Gunawardena, 2009). Education can also improve the opportunity for women to participate in paid employment and improve their career path than for illiterate women, as paid employment enables empowerment and autonomy (Bennett & Sung, 2013). Financial autonomy is a vital aspect necessary for supporting the healthcare needs of women and their children (Malhotra et al., 2012; Senarath & Gunawardena, 2009). Participation of women in leadership and parliament helps bring attention to organisational and policy-level changes in favour of gender equality and reproductive health. Factors such as equal pay, parental leaves, childcare support and equal opportunities for women help to further enhance women's autonomy for both general and reproductive healthcare. Additionally, the absence of violence and child marriage improves autonomy and provides an opportunity to fully participate and grow in all other domains of gender equality such as education, paid employment and participation in leadership and parliament. As a

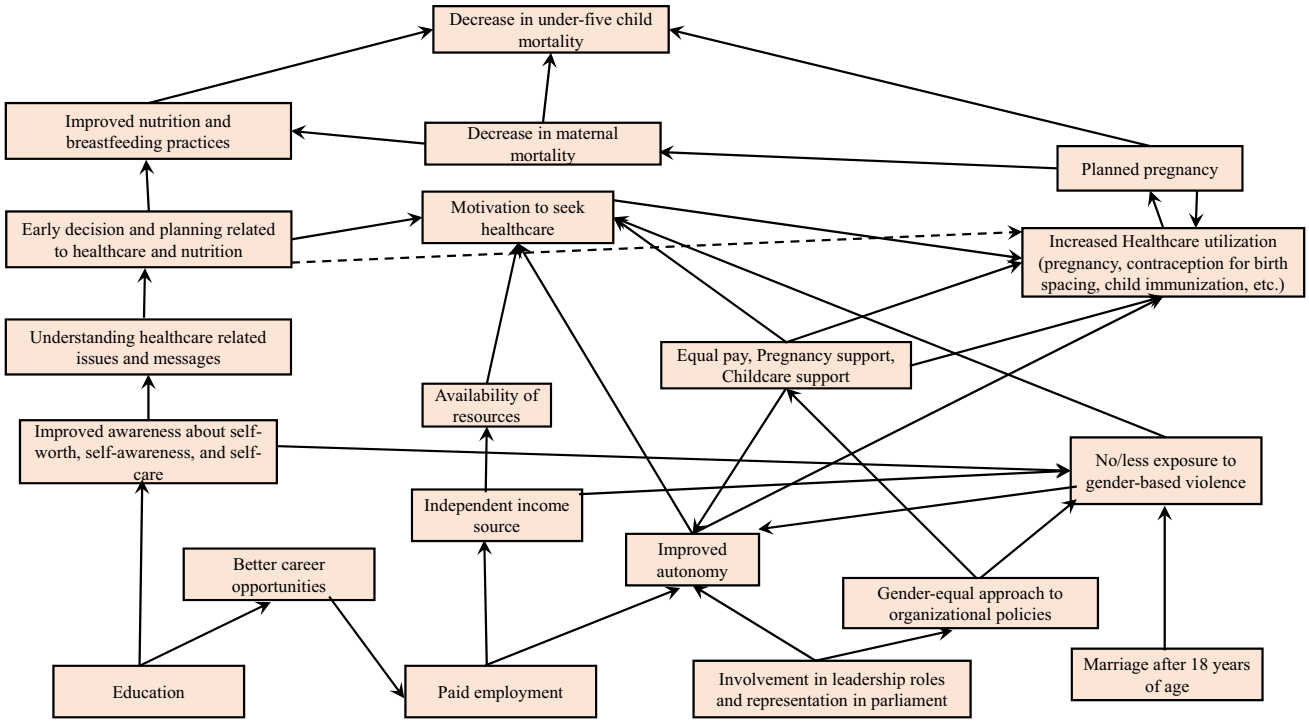


Fig. 1 Conceptual framework of potential association between gender equality and under-five child mortality

result of these factors, healthcare service use and contraception use can occur, reducing maternal mortality. Women's autonomy also helps to improve decisions regarding childcare, such as healthcare use and immunisation. Improvement in mother's education increases awareness about breastfeeding and the child's nutritional needs and fulfils the unmet need for contraception for planned pregnancy and birth spacing. All factors together reduce under-five child mortality.

Country Selection

We included relevant data representing all 193 UN member states. Non-member observer states, namely the Holy See and the State of Palestine, dependant territories and countries with free association with UN member countries, areas of exclusive sovereignty (autonomous territories), and non-self-governing countries were excluded from the study.

Variable Selection

In 2001, the Economic Commission for Latin America and the Caribbean (ECLAC) published a report on the tools and indicators of gender impact analysis, monitoring and evaluation (ECLAC, 2002). The report was the only internationally recognised inventory of available gender indicators (ECLAC, 2002). The gender development indicators were identified through the Economic Commission's report, which also provided details of the data source for particular variables. Data cleaning and statistical analysis were carried out using MS-Excel® and Stata 15®. The unit of analysis was an aggregated summary statistic for relevant variables for each country.

Timeline Selection

Data reported by countries is usually via national census data, the UN and other international agencies such as the USAID's Demographic Health Survey program data. Several low- and middle-income countries conduct a census at different time points based on resources and national policies. However, the frequency of data collection is not uniform, which makes it challenging to choose data sources from a single year globally. As the MDGs era (2000–2015) saw hastened efforts to improve data collection and reporting, the latest observations from 2000 to 2017 were included in this analysis.

Variable Selection for Statistical Analysis

The variables were grouped into different domains based on the conceptual framework: female education, women's employment and income, participation in leadership and parliament and the prevalence of GBV. Where multiple variables existed for one domain (e.g., education, paid employment and leadership representation), the main variables for the domain were chosen by considering whether

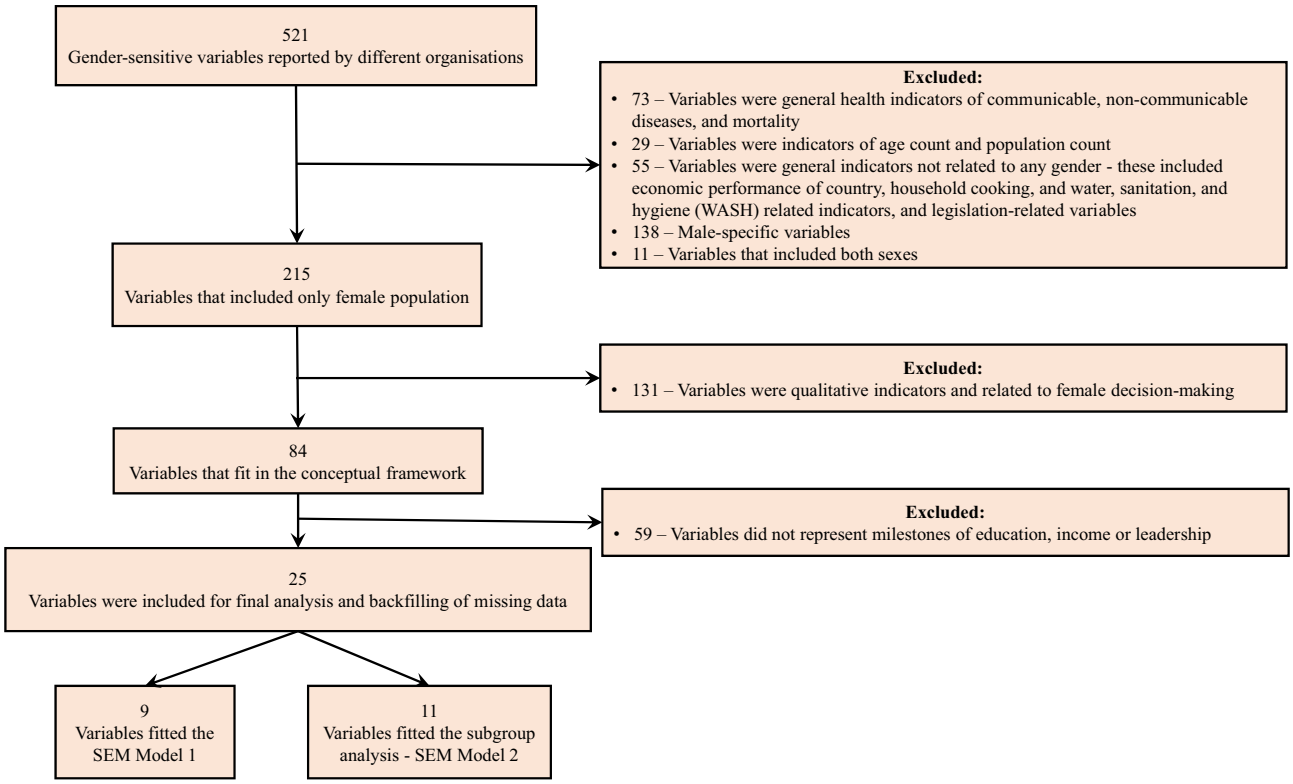


Fig. 2 Flow chart of variable selection. *SEM* Structural equation modelling; *WASH* Water, sanitation and hygiene

they represented a significant milestone or completion of that variable. For example, completion of primary education was the main variable instead of enrolment rates. Due to considerable variation in reporting practices of countries and organisations was responsible for missing data for all variables, we backfilled missing data using proxy variables when appropriate. Huang et al. have suggested that the technique of backfilling missing data with proxy data on neighbourhood affluence plays a highly significant role in missing data analysis (Huang et al., 2005). The list of proxy variables and their definitions are contained in the supplementary material.

131 qualitative variables were answers to questions on women's decision-making. However, the variables were excluded because of a very low sample sizes. Figure 2 summarises the steps involved in the variable selection process, and Table 1 summarises variables used in both models.

Statistical Method

Variables hypothesised to be influenced by gender equality were summarised using means and medians (min/max). Missing data remained a challenge for variables related to GBV. As this variable was hypothesised to have a strong relationship between the predictor and outcome, two structural equation modelling (SEM) models were designed. For this study, model 1 included nine variables (i.e., literacy rate, primary education attainment, secondary education attainment, tertiary education attainment, waged and salaried workers, female employers, female share in leadership roles and their representation in parliament) representing 193 countries. 37 countries were missing both IPV and child marriage variables. According to a systematic review by Bagade et al., GBV variables were associated with U5MR (Bagade et al., 2019). The large missingness can lead to inaccurate statistical modelling. Therefore, to determine the effect of these two variables, a subgroup analysis was conducted by excluding 37 countries in model 2. Model 2 was a subgroup analysis that included two extra variables, IPV and child marriage, for 158 countries.

SEM is a statistical method that takes a confirmatory approach to test whether the relevant set of observed variables are consistent with the proposed theoretical hypotheses (Bentler, 1988). The path analysis in SEM specifies in detail the process of inter-related effects of variables on a particular non-observed variable, as well as any specific outcome variables that need to be tested (Bentler, 1988). SEM was used to quantify relationships between the latent variable and its indicators and to establish whether gender equality is a significant predictor of U5MR. Gender equality was specified as a latent variable with paths to the observed variables. The outcome variable U5MR, and a covariance arrow was used to indicate a correlation between latent and outcome

Table 1 Details of selected gender equality variables used to backfill missing data

No.	Variables[a]	Missing data (n = 193) (%)	Variable name used in SEM[b]	Missing data after backfilling (%)
1	Literacy rate	21.76	NA	21.76
2	Main variable: Primary education attainment	29.53	Primary education attainment	2.07
	Proxy variables: Secondary enrolment—gross	5.18		
	Secondary enrolment—net	11.92		
	Progression to secondary school	16.58		
3	Main variable: Post-secondary education attainment	25.91	Secondary education attainment	6.22
	Proxy variables: Upper secondary education attainment	25.39		
	Lower secondary education completion	25.91		
	Tertiary school enrolment—gross	10.36		
	Education attainment—short tertiary	25.39		
4	Main variable: Education attainment—short tertiary	25.39	Tertiary education attainment	23.83
	Proxy variables: Education attainment—bachelors	49.74		
	Education attainment—masters	54.40		
	Education attainment—doctoral	62.18		
5	Main variable: Firms with female ownership	25.39	Leadership participation	12.44
	Proxy variables: Houses with a female head of the house	62.69		
	Firms with a female in senior or middle management	50.26		
	Firms with females at top management	34.20		
6	Main variable: Child marriage	41.28	Child marriage	22.15
	Proxy variables: Married before 18 years of age	36.27		
	Married before 15 years of age	36.27		
7	Waged and salaried workers	8.29	NA	8.29
8	Female employers	8.29	NA	8.29
9	Vulnerable employment	8.29	NA	8.29
10	Female representation in parliament	0.52	NA	0.52
11	Intimate partner violence	44.04	NA	44.04
12	Under-five mortality rate	1.04	NA	1.04

NA Not applicable

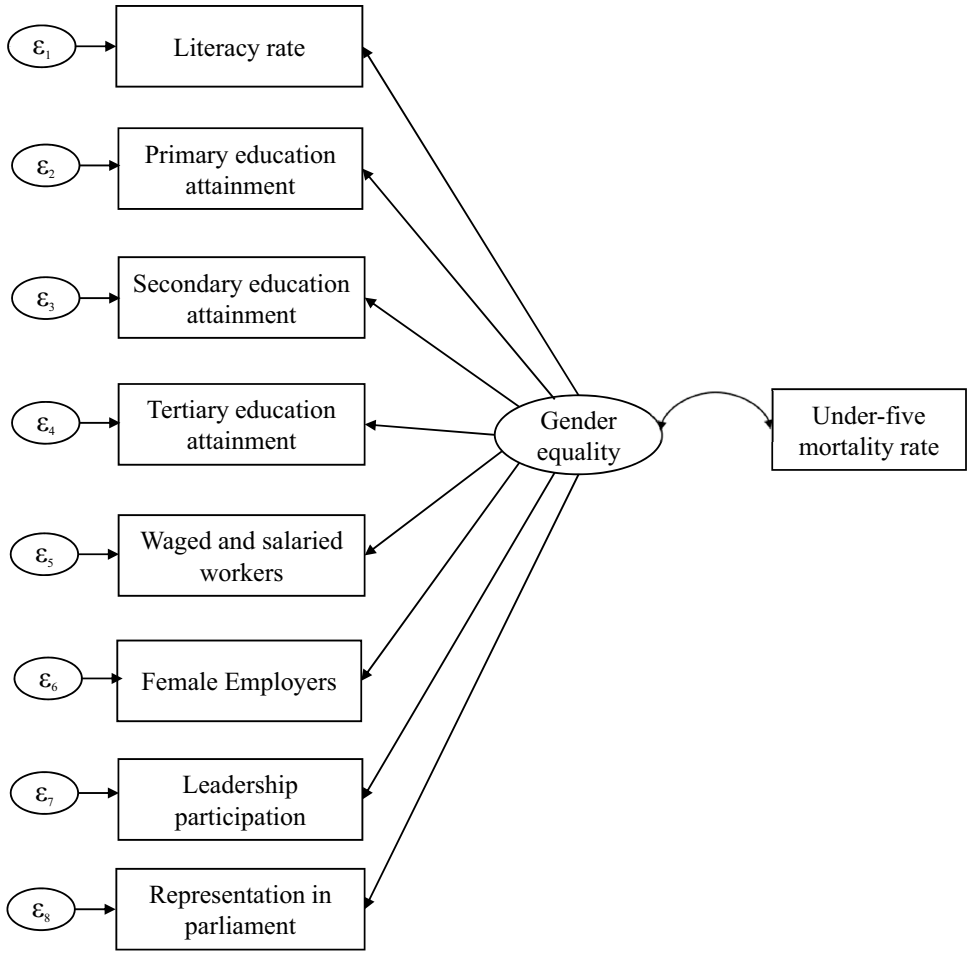
[a]Variables used for backfilling missing data; [b] Variable name used in SEM after backfilling data from proxy variables

variables. SEM estimates were analysed using maximum likelihood with missing values option and robust variance estimation (Huber/Whites/sandwich) to account for the non-normality and heteroscedasticity present in the variable distributions. Systematic deletion of variables that made the model unfit was conducted to ensure model fit. The model estimates were assessed for goodness of fit using a range of metrics. The statistical significance was indicated by $p < 0{\cdot}05$. The SEM diagrams for both models are displayed in Figs. 3 and 4.

Results

Nine variables fitted Model 1, and 11 variables fitted Model 2. The summary statistics for both models are mentioned in Tables 2 and 3. Both SEM models achieved convergence.

Fig. 3 SEM Model 1



The model estimates demonstrated that the gender equality construct was statistically significantly associated with U5MR. As gender equality increased, U5MR decreased (Z = − 7·47, CI = − 754.67 to − 440.98, $p < 0.001$, n = 193 for Model 1, and Z = − 7.71, CI = − 808.26 to − 480.72, $p < 0{\cdot}001$, n = 158 for Model 2). The model also quantified the relationship between each observed variable and gender equality, finding that increasing primary, secondary and tertiary education attainment, waged and salaried employment, female employers and women's representation in leadership roles were associated with increased gender equality. Apart from the same findings, Model 2 (subgroup analysis) estimates also indicated that child marriage and IPV prevalence was strongly associated with decreased gender equality. Comparison of Model 1 and Model 2 showed that women's representation in parliament was significantly associated with gender equality in Model 2. The coefficients of the hypothesised relationships in both the models were a good fit to the observed data; Model 2 scored higher on the goodness of fit index than Model 1. The summary statistics (see Tables 2 and 3), estimation results (see Tables 4 and 5), model variance (see Tables 6 and 7) and a comparison of the goodness of fit indicators for both SEM models (see Table 8) are provided below.

Discussion

The study used a women's rights-based approach to analyse 521 variables from 193 countries to determine the effect of gender equality on U5MR. The study found a clear association between gender equality and under-five child mortality globally. Women's education, waged and salaried employment, women as employers and representation of women in leadership and parliament significantly improved gender equality, whereas IPV and child marriage drastically reduced gender equality. Improvement in gender equality significantly reduced U5MR.

The study indicated a strong association between female education and gender equality and child mortality. Maternal education is a well-established indicator of gender equality (Boyle et al., 2006). Education empowers women and helps to improve women's autonomy in making health decisions, support better utilisation of available resources and motivates health-seeking behaviour for a child (Boyle et al.,

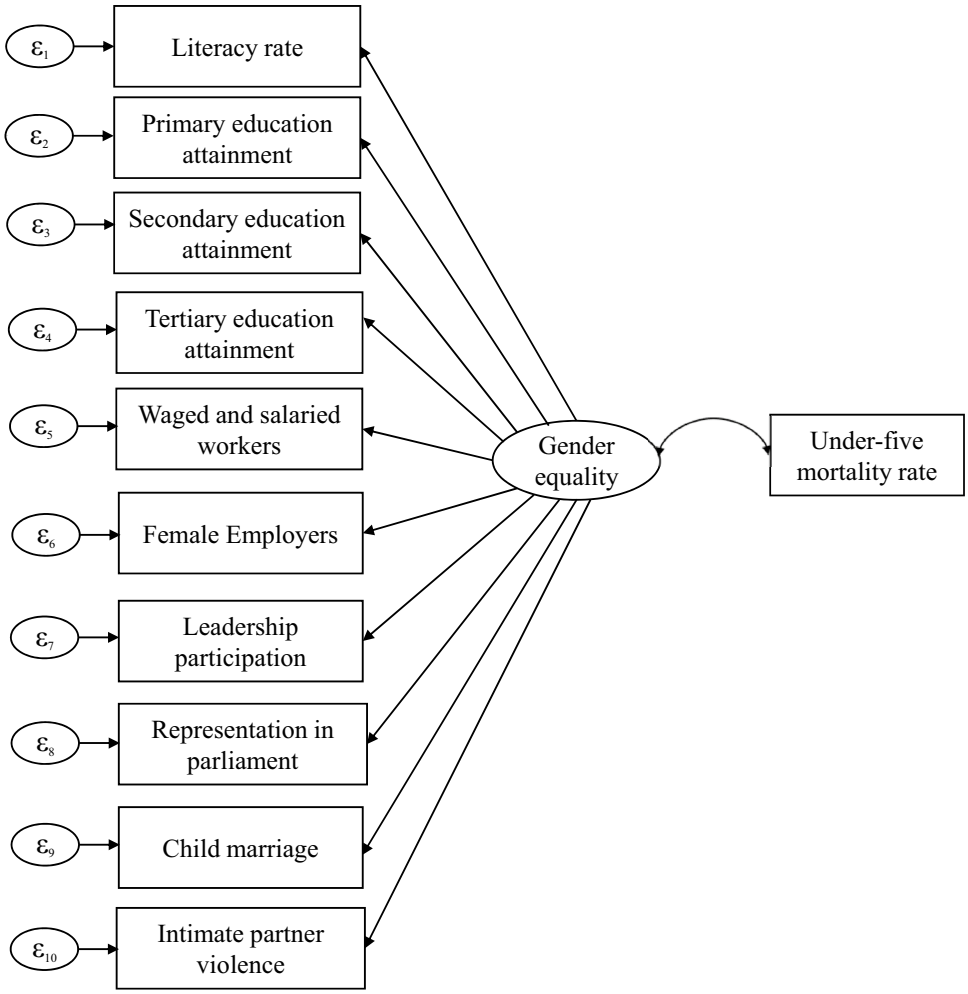


Fig. 4 SEM Model 2 (subgroup analysis)

2006; Malhotra et al., 2012; Song & Burgard, 2011). Educated women have significantly higher contraception uptake than do uneducated women, thereby improving birth spacing and preventing unintended pregnancies (Koch et al., 2014; Metcalfe et al., 2016; Patrikar et al., 2014). Further, improved child immunisation, care, and nutrition are observed if women are educated (Johri et al., 2015). Several studies have reported that women's education directly influences child survival (Abir et al., 2015; Boyle et al., 2006; Song & Burgard, 2011). The other crucial determinants of gender equality identified in our study were waged and salaried employment of women and female employers. Paid employment can improve financial autonomy and help to increase healthcare utilisation, which consequently affects child health (Abir et al., 2015). As women constitute almost half of the world's population, their leadership and political representation in parliament are crucial in implementing women's rights and striving towards overall gender equality

Table 2 SEM Model 1 variables summary statistics

	Variable name	n	Missing data (%)	Mean	Std Dev	Min	Max
1	Literacy rate	151	21.76	77.97	24.90	13.96	99.99
2	Primary school education attainment	189	2.07	74.97	26.46	2.56	118.69
3	Secondary school education attainment	181	6.22	22.15	18.90	0	104.67
4	Tertiary education attainment	147	23.83	18.39	15.18	0	63.69
5	Waged and salaried workers	177	8.29	56.50	31.64	1.03	99.61
6	Female employers	177	8.29	1.81	1.45	0.04	10.77
7	Leadership participation	169	12.44	34.96	15.96	2.2	86.8
8	Representation in parliament	192	0.52	21.27	11.77	0	61.3
9	Under-five child mortality	191	1.04	29.37	29.37	2.1	127.2

Table 3 SEM Model 2 (subgroup analysis) summary statistics

	Variable name	n	Missing data (%)	Mean	Std Dev	Min	Max
1	Literacy rate	132	16.46	75.67	25.77	13.96	99.98
2	Primary school education attainment	155	1.90	71.49	27.58	2.56	118.69
3	Secondary school education attainment	149	5.70	19.14	16.78	0	75.15
4	Tertiary education attainment	123	22.15	16.80	14.56	0	58.57
5	Waged and salaried workers	152	3.80	52.15	31.37	1.03	99.61
6	Female employers	152	3.80	1.82	1.51	0.04	10.77
7	Leadership participation	148	6.33	34.31	15.65	2.2	86.8
8	Representation in parliament	158	0	21.87	12.19	0	61.3
9	Intimate partner violence prevalence	107	32.28	28.35	13.74	6.1	67.6
10	Child marriage	123	22.15	23.49	15.06	1.6	76.3
11	Under-five mortality ratio	158	0	33.24	30.69	2.1	127.2

Table 4 SEM Model 1 estimation results

Variable	Coefficient	Standard error	Z-score	*p*-value	95% Confidence interval	
Literacy rate	1 (constrained)					
Primary school education attainment	1.03	0.07	14.09	< 0.001	0.88	1.17
Secondary school education attainment	0.61	0.06	10.00	< 0.001	0.49	0.72
Tertiary education attainment	0.49	0.05	9.55	< 0.001	0.39	0.60
Waged and salaried workers	1.19	0.08	16.07	< 0.001	1.05	1.35
Female employers	0.016	0.003	4.54	< 0.001	0.01	0.02
Leadership participation	0.14	0.05	3.00	0.003	0.049	0.23
Representation in parliament	0.08	0.04	2.24	0.025	0.01	0.15
Mean under-five mortality rate	29.15	2.11	13.80	< 0.001	25.01	33.29
Cov (u5mr, gender_equality)	− 597.83	80.02	− 7.47	< 0.001	− 754.67	− 440.98

Table 5 Model 1 variance

	Coefficient	Standard error	95% Confidence interval	
var(e.literacy_1)	121.20	25.71	79.97	183.69
var(e·prim_edu_1)	165.76	25.04	123.28	222.88
var(e.sec_edu_1)	171.04	37.60	111.16	263.18
var(e·tertiary_edu)	112.02	16.83	83.45	150.38
var(e.wage_salaried1)	224.64	30.74	171.79	293.73
var(e.employers1)	1.96	0.55	1.134	3.38
var(e.leadership_1)	243.13	27.48	194.82	303.41
var(e.parliament1)	134.47	14.08	109.51	165.11
var(u5mr)	859.33	107.24	672.88	1097.46
var(gender_equality)	519.14	74.84	391.36	688.64

(Commonwealth, 2013). Our study indicated that women's increased representation in leadership roles and parliament was significantly associated with better gender equality. Female parliamentarians can favour reproductive health, gender equality, and child health policies (IPU, 2008). Specific studies are needed to identify the particular dynamics of the effects of women in leadership and parliament on indirect causes of child mortality.

Child marriage and IPV are two significant indicators that denoted high levels of gender inequality in our study. Cross-sectional and cross-country studies of such scale rarely analyse these two indicators. Child marriage is a human rights issue and a significant risk factor for causing maternal and child mortality (Nour, 2009), but several high-income countries do not report data on child marriage because of its lower or hidden prevalence. However, it remains a significant human rights issue, as many countries have weak policies to prevent child marriage (Arthur et al., 2014; Nour, 2009). Adolescent birth rate and teenage pregnancy rate are other indicators that require attention. Compared with pregnancies in adulthood, higher rates of adverse outcomes are observed for children of adolescent mothers (Althabe et al., 2015). Girls below the age of 19 are considered adolescents or teenagers, yet this age is just 1 year more than the minimum age for legal marriage. A separate indicator is required to merge teenage pregnancies, adolescent pregnancies, and pregnancies because of child marriage. This indicator will enable countries to use the gender equality approach towards managing mortality associated with pregnancies of girls below

Table 6 SEM Model 2 (subgroup analysis) estimation results

Variable	Coefficient	Standard error	Z-score	*p*-value	95% Confidence interval	
Literacy rate	1 (constrained)					
Primary school education attainment	1.026	0.07	14.64	< 0.001	0.89	1.16
Secondary school education attainment	0.54	0.05	9.79	< 0.001	0.43	0.64
Tertiary education attainment	0.46	0.05	9.32	< 0.001	0.36	0.56
Waged and salaried workers	1.17	0.07	15.89	< 0.001	1.03	1.31
Female employers	0.02	0.003	4.70	< 0.001	0.01	0.03
Leadership participation	0.12	0.05	2.64	0.008	0.03	0.21
Representation in parliament	0.11	0.04	2.79	0.005	0.03	0.18
Intimate partner violence	− 0.19	0.05	− 3.64	< 0.001	− 0.29	− 0.09
Child marriage	− 0.51	0.05	− 10.23	< 0.001	− 0.61	− 0.41
Mean under-five mortality rate	33.24	2.44	13.62	< 0.001	28.46	38.03
cov(u5mr, gender_equality)	− 644.49	83.56	− 7.71	< 0.001	− 808.26	− 480.71

Table 7 Model 2 variance

	Coefficient	Standard error	95% Confidence interval	
var(e.literacy_1)	134.64	26.61	91.40	198.32
var(e.prim_edu_1)	180.15	29.11	131.25	247.26
var(e.sec_edu_1)	121.72	21.71	85.801	172.67
var(e.tertiary_edu)	98.55	16.61	70.823	137.13
var(e.wage_salaried1)	195.52	27.68	148.14	258.05
var(e.employers1)	2.081	0.62	1.1569	3.75
var(e.leadership_1)	235.06	30.18	182.75	302.32
var(e.parliament1)|	141.53	16.11	113.23	176.91
var(e.child_marriage_0)|	102.42	15.85	75.63	138.70
var(e.IPV)	165.77	25.13	123.16	223.13
var(u5mr1)	935.81	113.79	737.36	1187.67
var(Gender_equality)|	558.21	77.58	425.11	732.99

Table 8 Goodness of fit comparison Model 1 v. Model 2 subgroup analysis

Factor	Model 1	Model 2 (subgroup analysis)
n	193	158
Goodness of Fit Index	0.930	0.940
Akaike information criterion	12,303.2	12,129.51
Bayes information criterion	12,391.29	12,230.57

19 years of age. GBV-related data also need to be reported by every country. There is a strong negative association of all forms of IPV on contraception use and under-five child mortality (Abir et al., 2015; Emenike et al., 2008).

Women experiencing a violent relationship have lower odds of healthcare use for antenatal and postnatal care and higher odds of discontinuing exclusive breastfeeding before the recommended 6 months (Mohammed et al., 2017; Wallenborn et al., 2018). Moreover, women who have experienced IPV are less likely to visit healthcare facilities for their children's healthcare and immunisation (Bair-Merritt et al., 2008). Violence survivors are more likely to suffer from severe long-term mental health conditions that directly influence their children (Rees, & et al., 2011). However, despite concrete evidence that violence against women is a significant violation of human rights, protecting women's reproductive rights has rarely been a global priority (Cook, 1993). International commitments such as the 1979 Convention on the Elimination of all Forms of Discrimination Against Women (CEDAW) was ratified by 189 countries (UNWomen, 2018). Policy implementation to protect women's rights need major decisions at multiple levels (Yamin, 2013), social accountability, judicial enforcement, community-level advocacy, and addressing the underlying power relations dominated by men are the key issues that need attention. Upholding women's rights and gender equality will remain a distant dream unless countries prioritise ending all forms of violence against women.

The study has unique strengths and some limitations. Using summary statistics representative of each country for analysis and missing data for different variables decreased the sample size for the final statistical model, so causal inferences could not be achieved. The limitation was minimised by using SEM and the estimation method specific to manage missing data and small sample size.

The causes of child mortality are multi-systemic, and several medical and non-medical confounders such as health system issues can influence the study results. However, the health system approach towards child mortality is already discussed in the literature, with findings broadly indicating

that higher physician density and healthcare spending, access to clean water, sanitation and hygiene, and lower corruption rates were associated with lower U5MR (Muldoon et al., 2011). Instead of using the clinical or health system lens, we intended to use a women's rights approach to provide a different understanding of child mortality. Moreover, the women's rights approach allowed us to investigate some predominant issues of gender equality such as IPV, lower secondary education and representation of women in parliament and leadership, etc., that need to be addressed if we expect sustainable reductions in global U5MR. We selected all gender-sensitive variables that different international agencies reported, and indicators not associated with the conceptual framework of gender equality were excluded from the final analysis. The sophisticated methodology used for selecting variables, managing missing data and performing the statistics enabled us to minimise error in analysis or misinterpretation of the results. Primary, secondary and tertiary education attainment, waged and salaried workers, female employers, women in leadership roles, women in parliament, IPV and child marriage are the main indicators of gender equality. Global health policies should concentrate their efforts to influence these indicators to achieve gender equality. The final list of variables used for the SEM will be a vital tool for policymakers to develop initiatives to improve gender equality.

Conclusion

The results of this study provide compelling evidence for policymakers and researchers. Policies to improve funding for the higher education of women, creating more opportunities for paid employment for women, drastically increasing women's representation in politics and leadership, reducing IPV, and ending child marriages can substantially reduce under-five child mortality. A paradigm shift from a disease-based approach to a women's rights-based approach towards maternal and child health policies is needed if the world achieves the SDGs' child mortality targets. Several studies are still required to understand the multitude of problems faced by women globally. This study highlighted the need to improve data reporting of gender-based variables and simplify the extensive list of variables. Researchers can use the list of variables identified in this study to report on the progress of gender equality. Accelerated efforts are also needed to end child marriage and violence against women before the end of the SDGs and should be a primary goal of all countries over the next few years. The achievement of the SDGs will need a human rights-based approach, which is challenging but not impossible.

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Author Contributions TB was the principal author, conducted the statistical analysis and prepared the manuscript. TB, CC, MH and DL were involved in discussing the key concepts, designing the study methodology and providing input to the subsequent drafts. CO oversaw the statistical analysis and gave input for the methods and results section of the manuscript. The corresponding author had full access to information used in this study and had the final responsibility for the decision to submit for publication.

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Declarations

Conflict of interest We declare no competing interests.

Ethical Approval This study has received ethical approval from The University of Newcastle (Protocol No. H-2018-0251) on 1st August 2018.

References

ACHR. (2016). *Female Infanticide Worldwide: The case for action by the UN Human Rights Council*. Asian Centre for Human Rights (ACHR).

Abir, T., Agho, K. E., Page, A. N., Milton, A. H., & Dibley, M. J. (2015). Risk factors for under-5 mortality: Evidence from Bangladesh Demographic and Health Survey, 2004–2011. *British Medical Journal Open, 5*(8), e006722. https://doi.org/10.1136/bmjopen-2014-006722

Althabe, F., Moore, J. L., Gibbons, L., Berrueta, M., Goudar, S. S., Chomba, E., … McClure, E. M. (2015). Adverse maternal and perinatal outcomes in adolescent pregnancies: The Global Network's Maternal Newborn Health Registry study. *Reproductive Health, 12*(2), S8. https://doi.org/10.1186/1742-4755-12-S2-S8

Arthur, M., Atabay, E., Raub, A., Latz, I., de Guzman Chorny, N., Barrera, M., … Heymann, J. (2014). *Legal protections against child marriage around the world*. Retrieved from Los Angeles, CA

Bagade, T., Chojenta, C., Harris, M. L., Nepal, S., & Loxton, D. (2019). Does gender equality and availability of contraception

influence maternal and child mortality? A systematic review. *BMJ Sexual and Reproductive Health, 46*(4), 244–253. https://doi.org/10.1136/bmjsrh-2018-200184

Bair-Merritt, M. H., Crowne, S. S., Burrell, L., Caldera, D., Cheng, T. L., & Duggan, A. K. (2008). Impact of intimate partner violence on children's well-child care and medical home. *Pediatrics, 121*(3), e473. https://doi.org/10.1542/peds.2007-1671

Bennett, F., & Sung, S. (2013). Dimensions of financial autonomy in low-/moderate-income couples from a gender perspective and implications for welfare reform. *Journal of Social Policy, 42*(4), 701–719. https://doi.org/10.1017/S0047279413000330

Bentler, P. M. (1988). Causal modeling via structural equation systems. In J. R. Nesselroade & R. B. Cattell (Eds.), *Handbook of multivariate experimental psychology* (pp. 317–335). Springer.

Boyle, M. H., Racine, Y., Georgiades, K., Snelling, D., Hong, S., Omariba, W., … Rao-Melacini, P. (2006). The influence of economic development level, household wealth and maternal education on child health in the developing world. *Social Science & Medicine, 63*(8), 2242-2254. https://doi.org/10.1016/j.socscimed.2006.04.034

Brinda, E. M., Rajkumar, A. P., & Enemark, U. (2015). Association between gender inequality index and child mortality rates: A cross-national study of 138 countries. *BMC Public Health, 15*(1), 97. https://doi.org/10.1186/s12889-015-1449-3

Commonwealth S. (2013). *The impact of women's political leadership on democracy and development-case studies from the commonwealth*. Commonwealth Secretariat.

Cook, R. J. (1993). International human rights and women's reproductive health. *Studies in Family Planning, 24*(2), 73–86. https://doi.org/10.2307/2939201

CreativeCommons. (2018). Attribution 4.0 International (CC BY 4.0). Retrieved from https://creativecommons.org/licenses/by/4.0/

ECLAC. (2002). *Tools and indicators for gender impact analysis, monitoring and evaluation: ECLAC* ([ACC/]IAMWGE/2001/5). Retrieved from New York: https://docplayer.net/11736180-Tools-and-indicators-for-gender-impact-analysis-monitoring-and-evaluation-task-manager-eclac.html

Emenike, E., Lawoko, S., & Dalal, K. (2008). Intimate partner violence and reproductive health of women in Kenya. *International Nursing Review, 55*(1), 97–102. https://doi.org/10.1111/j.1466-7657.2007.00580.x

Gipson, J. D., Koenig, M. A., & Hindin, M. J. (2008). The effects of unintended pregnancy on infant, child, and parental health: A review of the literature. *Studies in Family Planning, 39*(1), 18–38. https://doi.org/10.1111/j.1728-4465.2008.00148.x

Huang, R., Liang, Y., & Carriere, K. C. (2005). The role of proxy information in missing data analysis. *Statistical Methods in Medical Research, 14*(5), 457–471. https://doi.org/10.1191/0962280205sm411oa

ILO. (2017). *ILOSTAT-The leading source of labour statistics—Bulk download facility*. Retrieved from https://ilostat.ilo.org/data/bulk/

IPU. (2008). *Equality in Politics: A survey of men and women in Parliaments*. Retrieved from Geneva, Switzerland: http://www.ipu.org/pdf/publications/equality08-e.pdf

IPU. (2017). *Global data on national parliaments*. Retrieved from https://data.ipu.org/search

Iqbal, N., Gkiouleka, A., Milner, A., Montag, D., & Gallo, V. (2018). Girls' hidden penalty: Analysis of gender inequality in child mortality with data from 195 countries. *BMJ Global Health, 3*(5), e001028–e001028. https://doi.org/10.1136/bmjgh-2018-001028

Johri, M., Subramanian, S. V., Sylvestre, M.-P., Dudeja, S., Chandra, D., Koné, G. K., … Pahwa, S. (2015). Association between maternal health literacy and child vaccination in India: A cross-sectional study. *Journal of Epidemiology and Community Health, 69*(9), 849-857. https://doi.org/10.1136/jech-2014-205436

Khosla, R., Banerjee, J., Chou, D., Say, L., & Fried, S. T. (2017). Gender equality and human rights approaches to female genital mutilation: A review of international human rights norms and standards. *Reproductive Health, 14*(1), 59. https://doi.org/10.1186/s12978-017-0322-5

Koch, E., Calhoun, B., Aracena, P., Gatica, S., & Bravo, M. (2014). Women's education level, contraceptive use and maternal mortality estimates. *Public Health, 128*(4), 384–387. https://doi.org/10.1016/j.puhe.2014.01.008

Liu, L., Oza, S., Hogan, D., Perin, J., Rudan, I., Lawn, J. E., … Black, R. E. (2015). Global, regional, and national causes of child mortality in 2000–13, with projections to inform post-2015 priorities: an updated systematic analysis. *The Lancet, 385*(9966), 430–440. https://doi.org/10.1016/S0140-6736(14)61698-6

Malhotra, C., Malhotra, R., Østbye, T., & Subramanian, S. V. (2012). Maternal autonomy and child health care utilization in India: Results from the National Family Health Survey. *Asia Pacific Journal of Public Health, 26*(4), 401–413. https://doi.org/10.1177/1010539511420418

Maxwell, L., Devries, K., Zionts, D., Alhusen, J. L., & Campbell, J. (2015). Estimating the effect of intimate partner violence on women's use of contraception: A systematic review and meta-analysis. *PLoS ONE, 10*(2), e0118234. https://doi.org/10.1371/journal.pone.0118234

Meiksin, R., Meekers, D., Thompson, S., Hagopian, A., & Mercer, M. A. (2015). Domestic violence, marital control, and family planning, maternal, and birth outcomes in Timor-Leste. *Maternal & Child Health Journal, 19*(6), 1338–1347. https://doi.org/10.1007/s10995-014-1638-1

Metcalfe, A., Talavlikar, R., du Prey, B., & Tough, S. C. (2016). Exploring the relationship between socioeconomic factors, method of contraception and unintended pregnancy. *Reproductive Health, 13*, 28. https://doi.org/10.1186/s12978-016-0151-y

Mohammed, B. H., Johnston, J. M., Harwell, J. I., Yi, H., Tsang, K.W.-K., & Haidar, J. A. (2017). Intimate partner violence and utilization of maternal health care services in Addis Ababa, Ethiopia. *BMC Health Services Research, 17*(1), 178. https://doi.org/10.1186/s12913-017-2121-7

Muldoon, K. A., Galway, L. P., Nakajima, M., Kanters, S., Hogg, R. S., Bendavid, E., & Mills, E. J. (2011). Health system determinants of infant, child and maternal mortality: A cross-sectional study of UN member countries. *Globalization and Health, 7*(1), 42. https://doi.org/10.1186/1744-8603-7-42

Nour, N. M. (2009). Child marriage: A silent health and human rights issue. *Reviews in Obstetrics and Gynecology, 2*(1), 51–56.

Okenwa, L., Lawoko, S., & Jansson, B. (2011). Contraception, reproductive health and pregnancy outcomes among women exposed to intimate partner violence in Nigeria. *European Journal of Contraception & Reproductive Health Care, 16*(1), 18–25. https://doi.org/10.3109/13625187.2010.534515

Patrikar, S. R., Basannar, D. R., & Seema Sharma, M. (2014). Women empowerment and use of contraception. *Medical Journal Armed Forces India, 70*(3), 253–256. https://doi.org/10.1016/j.mjafi.2013.12.014

Raitio, K., Kaunonen, M., & Aho, A. L. (2015). Evaluating a bereavement follow-up intervention for grieving mothers after the death of a child. *Scandinavian Journal of Caring Sciences, 29*(3), 510–520. https://doi.org/10.1111/scs.12183

Rees, S., Silove, D., Chey, T., et al. (2011). Lifetime prevalence of gender-based violence in women and the relationship with mental disorders and psychosocial function. *JAMA, 306*(5), 513–521. https://doi.org/10.1001/jama.2011.1098

Sedgh, G., Singh, S., & Hussain, R. (2014). Intended and unintended pregnancies worldwide in 2012 and recent trends. *Studies in Family Planning, 45*(3), 301–314. https://doi.org/10.1111/j.1728-4465.2014.00393.x

Sen, A. (2005). Human rights and capabilities. *Journal of Human Development, 6*(2), 151–166. https://doi.org/10.1080/14649880500120491

Senarath, U., & Gunawardena, N. S. (2009). Women's autonomy in decision making for health care in south Asia. *Asia Pacific Journal of Public Health, 21*(2), 137–143. https://doi.org/10.1177/1010539509331590

Song, S., & Burgard, S. A. (2011). Dynamics of inequality: Mother's education and infant mortality in China, 1970–2001. *Journal of Health & Social Behavior, 52*(3), 349–364. https://doi.org/10.1177/0022146511410886

Starbird, E., Norton, M., & Marcus, R. (2016). Investing in family planning: Key to achieving the sustainable development goals. *Global Health: Science and Practice, 4*(2), 191. https://doi.org/10.9745/GHSP-D-15-00374

UIS-UNESCO. (2017). *Bulk data download service*. Retrieved from https://apiportal.uis.unesco.org/bdds

UN-IGME. (2015). *Levels & trends in child mortality: Report 2010: Estimates developed by the UN Inter-Agency Group for Child Mortality Estimation*. Retrieved from New York, USA

UN. (2014). *Women's rights are human rights*. United Nations Publication.

UNDP. (2016). *Human development report technical notes*. Retrieved from www.hdr.undp.org/sites/default/files/hdr2016_technical_notes_0.pdf

UNDP. (2017). Human Development Data (1990–2018). *United Nations Development Programme—Human Development Reports.* Retrieved from http://hdr.undp.org/en/data

UNSD-UNdata. (2019). UN datamart Explorer. Retrieved from http://data.un.org/Explorer.aspx

UNWomen. (2018). CEDAW and Human rights—Frequently asked questions (FAQ) about CEDAW. *CEDAW and Human rights.* Retrieved from http://asiapacific.unwomen.org/en/focus-areas/cedaw-human-rights/faq#whatstateparties

Wagner, Z., Heft-Neal, S., Bhutta, Z. A., Black, R. E., Burke, M., & Bendavid, E. (2018). Armed conflict and child mortality in Africa: A geospatial analysis. *The Lancet, 392*(10150), 857–865. https://doi.org/10.1016/S0140-6736(18)31437-5

Wallenborn, J. T., Cha, S., & Masho, S. W. (2018). Association between intimate partner violence and breastfeeding duration: Results from the 2004–2014 pregnancy risk assessment monitoring system. *Journal of Human Lactation, 34*(2), 233–241. https://doi.org/10.1177/0890334418757447

Were et al., 2015Were, W. M., Daelmans, B., Bhutta, Z., Duke, T., Bahl, R., Boschi-Pinto, C., … Bhan, M. K. (2015). Children's health priorities and interventions. *BMJ: British Medical Journal, 351*, h4300. https://doi.org/10.1136/bmj.h4300

WorldBank. (2017). *Search and share development data*. Retrieved from https://datacatalog.worldbank.org/

Yamin, A. E. (2013). From ideals to tools: Applying human rights to maternal health. *PLoS Medicine, 10*(11), e1001546. https://doi.org/10.1371/journal.pmed.1001546

You, D., Hug, L., Ejdemyr, S., Idele, P., Hogan, D., Mathers, C., … Alkema, L. (2015). Global, regional, and national levels and trends in under-5 mortality between 1990 and 2015, with scenario-based projections to 2030: A systematic analysis by the UN Inter-agency Group for Child Mortality Estimation. *The Lancet, 386*(10010), 2275–2286. https://doi.org/10.1016/S0140-6736(15)00120-8

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