# Global patterns of gender inequality in mortality

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## INTRODUCTION

Paradoxically, alongside the almost universal and historical evidence that mortality has always been relatively higher among men than women, there has also been, almost universally, a historical oppression of women through patriarchy. This oppression imposes gender division of rights, duties and behaviours that influences the intensity of mortality by sex.

As McKeown (1976) points out, while biological factors confer a survival advantage to women in most age groups, this advantage was historically offset, at least partially, by the elevated risks associated with childbirth and poor maternal health conditions. Only with the decline in maternal mortality - primarily driven by improvements in living standards, nutrition, sanitation and basic medical care rather than by medical interventions alone - did the female survival advantage become fully expressed. Moreover, McKeown highlights that the persistent excess male mortality is not merely biological but is also reinforced by socially mediated behaviors, such as higher exposure to risk-taking, violence, and occupational hazards among men. This reinforces the notion that gendered social structures, including the patriarchal division of labor and social expectations, are deeply intertwined with the observed sex differentials in mortality over time.

Gender can be understood through three interrelated dimensions: as a fundamental organizing principle of society that assigns distinct roles to men and women; as a socially constructed concept shaped by cultural and historical contexts; and as a phenomenon deeply intertwined with systems of inequality and power dynamics. This perspective highlights that gender is not only present in the individual's life but also embedded within

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social institutions. Viewing gender as an integral aspect of social organization suggests that its measurement may vary across different contexts. It plays a crucial role in shaping economic structures, influences the design of education systems through gender roles, and is central to how societies define and understand reproduction. (Riley, 1999). Gender can be defined also like the characteristics of women, men, girls and boys that are socially constructed. As a social construct, gender varies from society to society and can change over time (World Health Organization).

In this study, gender is defined as a binary variable - male and female - based on the sex variable - men and women. As a result, the analysis will focus exclusively on these two categories, with particular emphasis on the gender inequalities that disproportionately impact women.

We can define two types of environments for women: the more extremist and the less extremist. Currently, some of the actions that subjugate women in more extremist environments are those that nullify any control they may have over their existence; the banning of women from studying; the prohibition of women's participation in the labour market; violence against women and their submission to their partners demands; the preference for boys. In less extremist environments, gender inequality appears, for example, with the stigmatization of women who are not included in the current patriarchal system; in inequities between men and women in education and participation in the labour market; in violence against women; in women's greater commitment to domestic tasks and, in some cases, in the greater protection of boys in relation to girls in childhood. (Federici, 2004; Goldscheider et al., 2015; Lerner, 2019)

The perception of gender inequality can be fragile when evaluated solely through economic indicators. Each region has distinct cultural, religious, and historical factors that shape gender roles and behaviours, often rooted in patriarchal norms. Accurately estimating the prevalence of such abuses is challenging, as they are often ingrained in cultural practices and remain underreported, largely because they occur in the private sphere, particularly within the family. Thus, several ways to measure gender inequality has been produced.

This paper is part of a wider project aiming to stablish relationships between mortality differential by sex and gender inequality throughout the demographic transition and have as specific objective to define global patterns of gender inequality using the mortality sex ratios and life expectancy as key indicators. The countries' experience provides an age-geographic overview of mortality gender inequality. By conducting a multivariate analysis applied to mortality-related data, this paper aims to provide insights into violations of women's and girls' human rights.

The goal is to investigate whether substantial differences in gender roles are linked to excess female mortality. More specific, this paper measures gender inequality in mortality through two indicators: the Mortality Sex Ratio (MSR) and the life expectancy at birth ($E_0$), under the assumption that the demographic transition phases are related to them; we employ an age-geographical approach. We classified the MSR and $E_0$ according to countries, based on a proposed typology, while also considering specific age groups of interest (less than 1, 1-4, 15-49, 60-74) over the period 2018-2020 available in the WPP-2024 (UN-DESA, 2024). The point here is to estimate an **Indirect Gender Inequality Index (IGII)** as an alternative measure of the already existing Gender Inequality Index (GII)[3] .

This paper offers a comprehensive overview of global gender inequality, setting itself apart from other studies by using the sex-age-geographical specific mortality rates and MSR and $E_0$ to estimate an Indirect Gender inequality Index (IGII). By utilizing two mortality indicators (MSR and $E_0$) as the basis for a new gender inequality index, we believe this research could contribute to the design of public policies that promote gender equality. Additionally, it may help to connect the Mortality Transition Theory to the evolution of gender inequalities over time. This study also aims to contribute to the ongoing research discussion on how gender inequality influences mortality rates by sex across different age groups. It addresses challenges identified in previous studies, including those by Alkema et al. (2014), Brinda et al. (2015), Iqbal et al. (2018), Nepomuceno et al. (2021), Crimmins et al. (2010), Moura et al. (2015), Case & Paxson (2005), and Oksuzyan (2008), while also contributing to the findings of Vallin (2004), Wong et al. (2021), and Drevenstedt et al. (2008). Building upon these findings, this paper takes an indirect approach to developing a new gender inequality indicator.

## BACKGROUND

Despite consistent historical and global evidence that male mortality exceeds female mortality (McKeown, 1976; Luy, 2003; Vallin, 2004; Turra & Sivieiro, 2011; Zarulli et al., 2021), many women still experience widespread oppression, the effects of

[3] See conceptualization of GII in the section about Data.

which can diminish or even reverse the typical sex-based mortality gap. Among children aged 0 to 4 years, a cultural preference for boys often results in relatively higher mortality rates for girls. In fact, in societies with conscious preference for boys, a higher probability of female mortality, compared to male mortality, can happen; a fact that, due to biological factors inherent to the human species, would not be expected otherwise. In adulthood, when behavioural and biological factors lead to higher male mortality, a narrowing of the gap - or similar mortality rates between men and women - still signals gender inequality. This topic helps to understand the relation between Mortality Sex Ratio (MSR) and the life expectancy at birth (E0) considering the different levels of human development and different stages of Demographic Transition, between countries. And the estimation of **IGII** is important for defining gender-based public policies aimed at improving people's quality of life.

According to Vallin (2004), this devaluation of the female sex is at the origin of the excess mortality of girls observed even today in numerous developing countries. In Bangladesh, where, in the 1-4 age group, the mortality of girls is 50% higher than that of boys and associated essentially to the inequality of food rations and health care (Chen et al.,1981). In India, notably, the burden that the dowry system imposes on parents often makes a female birth a family catastrophe. In Algeria, it is possible to evidence girl's excess mortality from the third month of life, focusing exclusively on the exogenous component of infant mortality, while its endogenous component is, on the contrary, marked by a strong male excess mortality (Vallin, 1978 – apud Vallin, 2004). The phenomenon seems, as in Bangladesh, to be closely linked to the neglect of girls (Vallin, 1978 - apud Vallin, 2004). Even in sub-Saharan Africa, where statistics are too imprecise to isolate the different components of infant mortality, it is possible that, in a cultural context that is less favourable to women, the absence of a gender mortality gap is linked to unfavourable treatment of girls, who should otherwise have a lower infant mortality rate than boys (Gbenyon and Locoh, 1989 - apud Vallin, 2004). The link between women's social status, the value of boys and excess mortality of girls was particularly important in China, where ancient practices of female infanticide was associated to the 1979 one-child strategy (Calot & Caselli, 1988 - apud Vallin, 2004). In Anhui province, where the female infant mortality rate was 12% higher than the male rate, Zhang (1983) - apud Vallin (2004) estimated that infanticide, which could be responsible for 60% of infant deaths, was the main cause of this exceptional excess mortality of women under one year of age. And more recently, this distrust towards female babies has been observed, notably in India, in the practice of discriminatory feticide, which consists of eliminating female embryos after ultrasound (Miller, 1996). It is evident that the preference for male children, a manifestation of gender inequality, is prevalent in many countries and significantly impacts sex-specific mortality rates during the early years of life

In the literature, some authors, such as Alkema et al. (2014), Brinda et al. (2015), Iqbal et al. (2018), Marphatia at al. (2016), proved the positive association between gender inequality and higher levels of female infant and childhood mortality, than male´s. Alkema et al. (2014) found that decreasing mortality was associated with increasing sex mortality ratios (Male Mortality Rate/ Female Mortality Rate), except at very low infant mortality, where sex ratios decreased as total mortality did. Related to under-5 sex ratios the authors identified, for 2012, 15 outlier countries, of which ten (Afghanistan, Bahrain, Bangladesh, China, Egypt, India, Pakistan, Iran, Jordan, and Nepal) had female mortality higher than expected. Brinda et al. (2015) studied the association between child mortality rates and GII of 138 countries. Although without focusing on the sex differentials, the authors found that women in low-and-middle income countries suffer significantly more gender inequality. GII was positively associated with neonatal, infant and under five mortality rates. Iqbal et al. (2018) used the Gender Inequality Index (GII) to measure the gender inequality and data on sex-specific under-five mortality rates (U5MR) and the corresponding under five mortality sex ratio (U5MSR) for the year 2015 from UNICEF database. Like Brinda et al. (2015) results, GII was significantly negatively associated with U5MSR and, importantly, significantly positively associated with excess under-five female mortality. The association between GII and U5MSR was strong and statistically significant only in low and middle-income countries in the Western Pacific area. Marphatia (2016) investigated the association of GII with the prevalence of low birth weight (LBW), child malnutrition and U5MR, in 96 countries, adjusting by Gross Domestic Product (GDP). The GII displaced GDP as a predictor of LBW. Independent of national wealth, increasing women's empowerment relative to men may reduce LBW and promote child nutritional status and survival. Among children less than one year old, the probability of male mortality is expected to be higher due to congenital causes, while for females, in some regions, there is a higher likelihood of death from preventable causes (Vallin, 2004). Similarly, at ages 1 to 4 years, the probability of male mortality could be lower than that of females, which can lead to higher female death rates from preventable causes such as malnutrition, diarrhoea, or external causes (Marphatia et al. (2016)). These studies conclude that the more gender unequal a society is, the more girls are penalized in terms of their survival chances, in low-income and middle-income countries.

According to Vallin (2004), in France at the beginning of the 19th century, excess female mortality was still evident in childhood, adolescence and reproductive ages. Immediately after the Second World War, up to the age of 35, excess male mortality was almost the same as at birth, suggesting that women up to this age had already regained their biological advantage, while at older ages, men were still losing ground. From the 1950s onwards, while the worsening of excess male mortality continued and even accelerated in mature ages, a second explosion of excess male mortality brutally affected the age group immediately around 20 years. At the beginning of the 1970s, the excess male mortality rate exceeded 200% from 18 to 70 years, reaching 240% between 60 and 70 years and even 270% at 20 years. Afterwards, the relative situation of men worsened even further, with a peak of 350% at 20-22 years of age and a very high plateau at over 250% in adulthood. (Vallin, 2004)

In Australia, Sweden and Norway, for example, the increase in male life expectancy from 70 to nearly 75 years during the 1980s and 1990s resulted in a reduction in the sex difference of approximately one year in life expectancy. The same phenomenon is observed in the United States, but at a higher mortality level. Not only do male behaviours that are harmful to health make less and less of a difference, but in these countries, men have also managed to imitate, in part, positive female attitudes regarding prevention and seeking care. There is nothing to prevent us from thinking that the experience of Anglo-Saxon and Scandinavian countries could become widespread, and that almost everywhere men will end up recovering much of the ground they lost throughout the 20th century. (Vallin, 2004)

For adults and the elderly, there is another paradox regarding mortality, showing that, by age, despite expecting male’s mortality to be higher than female's, female health conditions are worse. Women tend to experience more hospitalizations, require more medical care, and report lower satisfaction with their health compared to men (Nepomuceno et al., 2021; Oksuzyan et al, 2021; Crimmins et al., 2010). Additionally, literature suggest that men are more affected by sudden causes of death, such as external factors and heart disease, whereas women tend to experience prolonged health conditions and treatments (Crimmins et al., 2010; Moura et al., 2015; Case & Paxson, 2005).

Oksuzyan et al. (2008) reviewed this problem examining sex differences in health and survival, with focus on the Nordic countries. The authors found that there are probably multiple causes, including fundamental biological differences between the sexes, such as genetic factors, immune system response, hormones and disease patterns. Behavioural differences such risk taking and reluctance to seek and comply with medical treatment also probably play a role. Some of the differences may be due to delays in seeking treatment by men, or bias in surveys, if men are more reluctant to than women to participate or accurately report in surveys about disabilities or diseases (Oksuzyan et al, 2008)

This reasoning raises several questions. In an ideal society - economically developed, with strong gender equality indicators and a well-balanced age distribution of the population - who, on average, lives longer: men or women? Is the paradox of life expectancy primarily driven by biological factors favouring one gender over the other? Or is it the result of unfavourable gender relations shaped by patriarchy? In this case, which gender would be advantaged or disadvantaged: men or women? Which factor has a greater impact: biological differences or societal gender inequality? What public policies should be implemented to improve the health of both men and women? Having this questioning in mind, this study gathers the previous background information with the behaviour of Mortality Sex Ratio (MSR) in a period perspective, to study gender relations and to give conditions to estimate the Indirect Gender Inequality Index (IGII).

The male disadvantage in infant mortality experienced a notable rise and subsequent decline over the course of the 20th century. Drevenstedt et al. (2008) analysed data from 15 developed countries and demonstrated that, as infant mortality declined over the past two centuries, excess male mortality increased—from approximately 10% in 1751 to over 30% around 1970. Interestingly, since 1970, this male disadvantage has declined in most countries. The increase in male excess mortality up to 1970 may be explained by sex-specific changes in cause-of-death patterns: declines in deaths from infectious diseases and a shift toward perinatal causes tended to favour female survival. Conversely, the reduction in male disadvantage after 1970 is likely associated with improvements in obstetric practices and neonatal care. These advances enabled more vulnerable male infants - such as those born prematurely or with low birth weight - to survive, though potentially with long-term health consequences. This analysis highlights significant historical shifts in the sex ratio of infant mortality.

Wong et al. (2021) analysed trends in sex differentials in mortality in Brazil between 2000 and 2018, focusing on the main causes of death. Their empirical findings reveal a bell-shaped pattern in sex-specific mortality ratios: for infant mortality, the sex differential is low when overall mortality is high, increases as mortality declines, and then returns to relatively low levels or disappears altogether. In the case of under-5 mortality, however, trends in the leading causes of death may, depending on the context, hinder the elimination of this differential. The study shows that the substantial reduction in child mortality in Brazil during the period was accompanied by a decline in the mortality sex ratio for most major causes of death - except for external causes, where the ratio remains relatively high. This persistence appears to reflect the harmful influence of gender dynamics, which disproportionately affect boys and anticipate a widening gap in mortality during adolescence and adulthood.

These topics are crucial for the understanding of the relationship between the Mortality Sex Ratio (MSR) and life expectancy at birth ($E_0$), considering varying levels of human development and different stages of demographic transition across countries. Besides, it contributes to the estimation of the Indirect Gender Inequality Index (IGII)

**DATA**

This study utilizes data from various sources, including the United Nations Life Tables (Population Prospects, 2024); the United Nations social and demographic indicators (Population Prospects, 2024); the Demographic Transition Indicator (Brito & Amaral, 2020) and the World Values Survey (Haerpfer et al., 2022; Inglehart et al., 2022). The analysis excluded countries with poor data quality; to ensure reliability, the selection of countries was based on the dataset provided by the World Values Survey (Haerpfer et al., 2022; Inglehart et al., 2022). Given the varying degrees of reliability in country statistics, the sources are critically evaluated.

The UN National Life Tables (POP/DB/WPP/Rev.2024/MORT/F07-2e3) were used for the period 2018 to 2020, ensuring that specific events were not overly emphasized[4]. Earlier estimates, before 1980, particularly in developing countries, often relied on pre-established models and data beyond 2020 primarily consists of projections. Data correspond to 82 countries covering the different phases of the demographic

[4] Deaths that occurred atypically in greater numbers during a specific period are smoothed out by the preceding and following periods, to reduce the impact of this adverse event, like COVID-19 epidemic.

transition, based on demographic censuses, supplemented by vital registration and surveys, depending on the quality of data available for each country. While adjustments are generally minimal for developed countries, significant modifications are often required for developing countries to enhance the accuracy of mortality estimates. UN data remains the most reliable source for this type of analysis. The data collected included national male and female mortality rates.

The Gender Inequality Index (GII), developed by the United Nations assesses gender-based disadvantage across three dimensions: reproductive health (including teenage pregnancy and maternal mortality), empowerment (measured by access to basic and superior education and representation in parliament), and labour market participation (man and women). Each dimension is normalized and combined to generate the index, ranging from 0 to 1. It quantifies the loss of human development potential due to gender inequality in these dimensions, with a range from 0, indicating perfect gender equality to 1, indicating complete disadvantage for women, across all dimensions. One of the main limitations of the GII is that it does not capture other important expressions of gender inequality, such as gender-based violence, unpaid work, and social discrimination. It relies on national data, which may be incomplete or inconsistent. The GII assigns equal weights to all dimensions, ignoring cultural and regional differences. Additionally, it does not account for inequalities within countries, such as those based on race or social class. Lastly, the GII places greater emphasis on female disadvantages, with less focus on male disparities. (Human Development Report, 2023). The GII was used to characterize the typology of countries and to compare it with the results obtained.

The Demographic Transition Index (DTI), developed by Brito and Amaral (2020), assesses the pace of demographic transition across different countries and classifies them based on their transition characteristics and phases. To measure the disparities between nations the authors employed a set of variables from 198 countries with data available from the United Nations Population Division's World Population Prospects 2017. Based on six indicators of age structure, a synthetic index is built using Principal Component Analysis (PCA). The six indicators are: a) Proportion of the population aged 65 and over; b) Youth dependency ratio, meaning the ratio of the population aged 0 to 14 to those aged 15 to 64; c) Elderly dependency ratio, that is, the ratio of the population aged 65 and over to those aged 15 to 64; d) Support capacity, which is the inverse of the elderly dependency ratio,; e) Aging index, which is the ratio of the population aged 65 and over to those aged

0 to 14; f) Median age. To improve the measurement of each nation's stage based on the temporal evolution of the mentioned indicators, Brito and Amaral (2020) estimated a synthetic index of demographic transition. For this purpose, they used Principal Component Analysis (PCA), considering data from the six previously listed indicators for the years 1950, 1980, 2020, 2040, and 2060. This indicator helped to establish a typology of countries, which was essential for analysing the results.

The World Values Survey (WVS) is a comprehensive global research project that examines people's values and beliefs, their evolution over time, and their social and political impacts. Since 1981, a global network of social scientists has conducted nationally representative surveys in nearly 100 countries as part of the WVS. It measures and analyses a range of factors, including support for democracy, tolerance of foreigners and ethnic minorities, gender equality, the role and changing levels of religiosity, the impact of globalization, and attitudes towards the environment. It also explores views on work, family, politics, national identity, culture, diversity, insecurity, and subjective well-being (Haerpfer et al., 2022 and Inglehart et al., 2022). In this study, the WVS provided a means to evaluate the level of human development across countries, extending beyond purely economic characteristics.

To create the Inglehart-Welzel cultural map (see appendix 3) proposed by Inglehart et al. (2022) and Haerpfer et al. (2022), they use two variables, one that measures the extent to which societies are traditional versus rational, and the other, the relative importance of survival values compared to self-expression values. Haerpfer et al. (2022) and Inglehart et al. (2022) constructed a cultural map that defines these two dimensions for each country analysed, as can be seen in **Appendix 3**. These two variables contributed to define the countries typology proposed in this study.

## METHODS

This study uses an inferential model to estimate an Indirect Gender Inequality Index (IGII), considering two variables Mortality Sex Ratio (MSR) and the life expectancy at birth *($E_0$),* employing an age-geographical approach. As mortality level is used, we are aware of the paradox of no-mortality sex differences in both maximum and minimum mortality levels situation, when MSR is located near 1.0. In the first case because highly exposition to the risk of death saves no lives regardless of sex, and in the second case, because lowest risk does save lives regardless of sex. MSR and $E_0$ were classified based on a proposed countries typology, while also considering specific age groups of interest (less than 1, 1-4, 15-49, 60-74) over the period 2018-2020.

This study is based on an economic model where the dependent variable, Y, represents the Mortality Sex Ratio (MSR), while the independent variables include $X_1$, representing the typology of countries, and $X_2$, representing age groups of interest. In this model, the MSR is determined by both the typology of countries, which reflects each country's overall development level, and age groups, as gender inequality varies across age groups and affects women in different populations uniquely. The model also incorporates life expectancy at birth, $X_3$. Additionally, the model includes an error term that could capture factors such as variations in public policies aimed at combating gender-related inequalities and abusive gender behaviours.

To have a more comprehensive view of the set of countries according to their stage in the following three dimensions: a. the demographic transition; b. cultural values or level of human development and, c. gender inequality; we classify them based on the indicators presented lines above.

In this model, the MSR is influenced by life expectancy at birth, a typology of countries (which reflects their overall development level), and age groups (as gender inequality affects different age groups in distinct ways). The model also includes an error term, μ, which accounts for factors not captured by the model. The model can be expressed as follows:

$$Y = \frac{MMR}{FMR} = MSR \tag{1}$$

$$X_1 = f(Var_1, Var_2, Var_3, Var_4\,) \tag{2}$$

$$\Omega_{X_1} = \{1, 2, 3, 4, \dots, 10\} \tag{3}$$

$$\Omega_{X_2} = \{0 - 1;\ 1 - 4;\ 15 - 49;\ 60 - 74\} \tag{4}$$

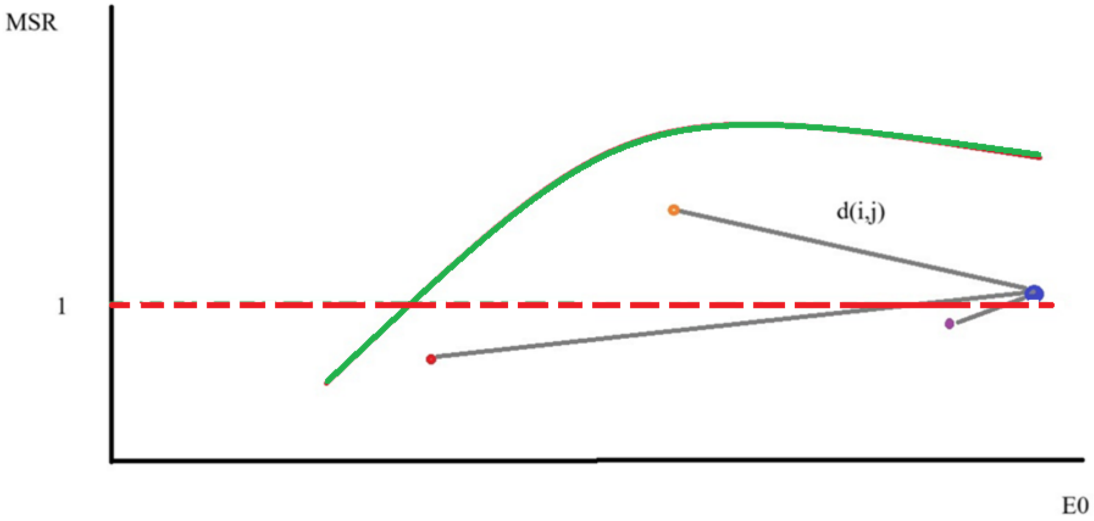
$$\Omega_{X_3} = \{0, \dots, 110\,\} \tag{5}$$

$$Y = f(X_1;\ X_2;\ X_3; \mu) \tag{6}$$

where *MMR* is the Male Mortality Rate, *FMR* is the Female Mortality Rate, $X_1$ is the country typology with 10 groups defined by clustering 4 variables, $X_2$ represents age group, $X_3$ represents the life expectancy at birth and μ is the model error, accounting for unobserved factors, like specific public policies. The variables used to define $X_1$ are those described in Data section (GII, DTI and 2 variables from WVS – traditional-rational and survival-self-expression).

To classify countries based on these four dimensions, we used cluster analysis. This method identifies groups within the data, ensuring that units within the same group are similar, while units in different groups are as dissimilar as possible (Kaufman & Rousseeuw, 1990). Specifically, we applied the Agglomerative Nesting (AGNES) clustering technique to classify the countries, allowing for a clear distinction between similar and dissimilar groups. Countries with missing information were excluded from the analysis.

**Figure 1 – Hypothetical Structure for estimating the Indirect Gender Inequality Index (IGII)**




- Green line: trend of theoretical MSR across $E_0$
- Red dotted line: MSR=1.0
- Blue circle: Theoretical MSR indicating gender inequality, $X_{j,j}$
- Gray lines: distance between each country and the theoretical equality point
- Small Orange circle: Country $X_1$
- Small Red circle: country $X_2$
- Small Purple circle: Country $X_3$

**Source:** Prepared by the authors

The Indirect Gender Inequality Index is estimated using two variables: the Mortality Sex Ratio (MSR) and life expectancy at birth, as illustrated in **Figure 1**. The red line in the figure represents the trend line of a scatter plot, showing the relationship between MSR and life expectancy at birth. At this point of our research, the green dotted line indicates equality, where MSR equals 1.0, or that MMR is equal to FMR. Important to mention that gender equality can result in a MSR above 1.0 (Arteaga, 2024). As explained in the literature review, due to the biological constitution of the male embryo/foetus/body, particularly at early ages, mortality is expected to be higher among male than female. The blue point marks the theoretical position of gender equality, calculated by averaging MSR and life expectancy at birth in the most developed countries, defined by the clustering techniques. The grey vectors represent the geometric distances between each country's data point (coloured points) and the theoretical equality point (blue).

$$d(i,j) = \sqrt{\left(X_i - X_j\right)^2 + \left(Y_i - Y_j\right)^2} \tag{7}$$

These distances, d(i,j), form the basis for calculating the **IGII**, where $(X_j, Y_j)$ is the reference point and $(X_i, Y_i)$ refer to axis X (life expectancy at birth) and Y (Mortality Sex Ratio) for each country analysed (coloured points). This index is estimated for 2020, covering 82 countries with nearly 90% of the world population, based on the group of countries selected by the World Values Survey. Considering this study purpose, and based on the typology of countries used, it is possible only to estimate the IGII for 82 countries, but if the typology is not needed for other purposes, the IGII can be estimated for all countries that have mortality estimates and national life tables.

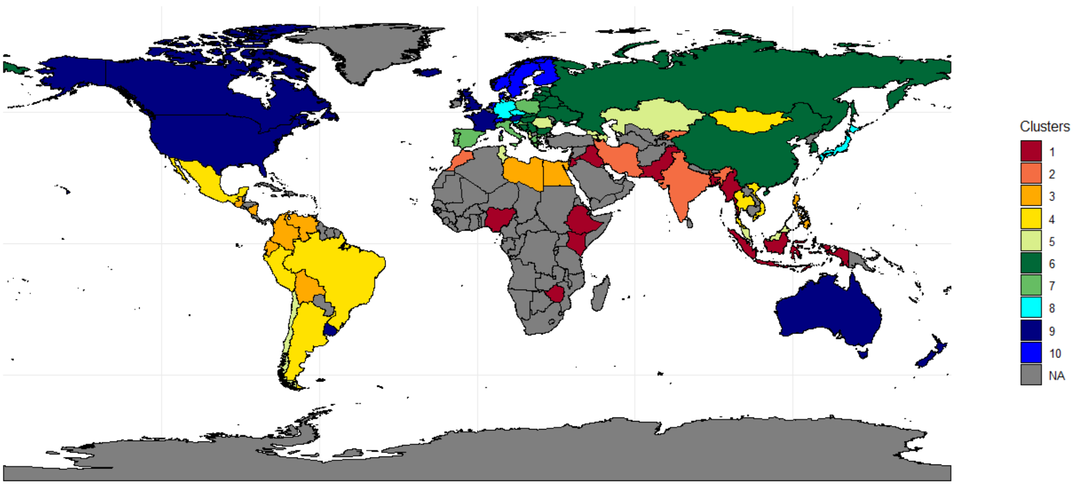
## RESULTS

There are 193 independent countries (**Appendix 1**) recognized by the United Nations (United Nations, 2023); however, as we used national data from the WVS in wave 7 (2017-2022), the list was reduced to 82 countries (**Appendix 2**). Besides the two key variables, Traditional-Rational and Survival-Self-expression, other variables are reported: Population growth rate (r-var), Human Development Index (HDI), Total Fertility Rate (TFR), Gender Inequality Index (GII) and Demographic Transition Index (DTI).

### *Countries Typology*

**Figure 2** presents the country typology developed to categorize the world according to demographic transition and human development levels, with a particular emphasis on the gender dimension in its definition. This typology of countries is part of a bigger research developed by Arteaga (2024).

**Figure 2-** Countries Typology according to demographic transition and human development levels




| Typology | Countries |
|---|---|
| 1 | Bangladesh, Myanmar, Ethiopia, Indonesia, Iraq, Jordan, Kenya, Nigeria, Pakistan, Zimbabwe |
| 2 | India, Iran (Islamic Republic of), Kyrgyzstan, Lebanon, Morocco |
| 3 | Bolivia (Plurinational State of), Colombia, Ecuador, Egypt, Guatemala, Libya, Maldives, Nicaragua, Philippines, Venezuela (Bolivarian Republic of) |
| 4 | Argentina, Brazil, Mongolia, Mexico, Peru, Thailand, Viet Nam |
| 5 | Azerbaijan, Albania, Armenia, Chile, Georgia, Kazakhstan, Malaysia, Romania, Tunisia |
| 6 | Bosnia and Herzegovina, Belarus, Bulgaria, China, Estonia, Hungary, Korea (Republic of), Latvia, Lithuania, Slovakia, Montenegro, Russian Federation, Serbia, Ukraine |
| 7 | Cyprus, Greece, Croatia, Italy, Poland, Portugal, Singapore, Spain |
| 8 | Czechia, Germany, Japan, Slovenia |
| 9 | Australia, Austria, Canada, France, Iceland, New Zealand, United Kingdom, United States, Uruguay |
| 10 | Denmark, Finland, Netherlands, Norway, Sweden, Switzerland |

**Source:** Basic data from World Population Prospects (2024), World Values Survey (2017-2020, wave 7) and United Nations.

**Table 1** characterizes the clusters of countries where Cluster 10 is the most economically developed and has the highest level of gender equality, while Cluster 1 is the least economically developed and shows the third greatest gender inequality. The cluster order reveals a gradient of human development, defined by the Human Development Index (HDI). In this typology clusters 1-3 are the least developed countries, 4-6 are the developing countries and 7-10 are the developed countries, which is considered to facilitate the analysis.

**Table 1-** Country Typology Characterization according to development, demographic, gender and attitudinal indicators (2020)

| Typology | Human Development Index<br>HDI 2021 | Gender Inequality Index<br>GII 2020 | Population Growth Rate<br>r_var 2020 | Total Fertility Rate<br>TFR 2020 | Demographic Transition Index<br>DTI 2020 | WVS Traditional-Rational Index<br>T-R (wave7) | WVS Survival-SelfExpression Index<br>S-SE (wave 7) |
|---|---|---|---|---|---|---|---|
| **(0)** | **(1)** | **(2)** | **(3)** | **(4)** | **(5)** | **(6)** | **(7)** |
| 1 | 0,610 | 0,527 | 1,82 | 3,28 | 18,50 | -1,12 | -0,99 |
| 2 | 0,698 | 0,435 | 0,64 | 2,25 | 29,35 | -0,52 | -0,85 |
| 3 | 0,706 | 0,407 | 1,15 | 2,35 | 25,65 | -1,50 | -0,37 |
| 4 | 0,765 | 0,330 | 0,85 | 1,98 | 32,94 | -0,48 | -0,01 |
| 5 | 0,791 | 0,228 | 0,33 | 1,89 | 40,12 | -0,37 | -0,88 |
| 6 | 0,831 | 0,151 | -0,54 | 1,47 | 53,60 | 0,74 | -0,51 |
| 7 | 0,890 | 0,083 | -0,11 | 1,31 | 55,86 | -0,07 | 0,05 |
| 8 | 0,919 | 0,087 | -0,08 | 1,53 | 62,76 | 1,21 | 0,81 |
| 9 | 0,918 | 0,102 | 0,58 | 1,61 | 51,67 | 0,04 | 1,68 |
| 10 | 0,950 | 0,021 | 0,52 | 1,55 | 56,65 | 0,78 | 2,23 |

1) HDI ranges from 0,0 to 1,0, where the lowest the score the less the development degree.
2) GII ranges from 0,0 to 1,0, where the lowest the score the less the gender inequality
3) r-var can be negative or positive depending on the population is increasing or decreasing
4) TFR is the mean number of children per women in the population
5) DTI ranges from o to 100, where the lowest the score more delayed in Demographic Transition
6) Traditional-Rational can be negative or positive, where the lowest the score is, stronger is the tendency to a more traditional society
7) Survival-SelfExpression can be negative or positive, where the lowest the score is, stronger is the tendency to more concerns about the survival

**Source:** Data from World Population Prospects (2024), World Values Survey (2017-2020, wave 7) and United Nations.

**Table 1** shows that the GII is negatively correlated with both the HDI and the DTI. In other words, the lower the GII (indicating a more egalitarian society), the higher the HDI (indicating a more developed country) and the higher the DTI (indicating further progress in the Demographic Transition). This result aligns with the Demographic Transition Theory, which suggests that as a country progresses through the Demographic Transition, it becomes more economically developed and experiences reduced gender inequality. There is a highly positive correlation between TFR and r-var. This level of correlation can be attributed to r-var being influenced by migration and mortality, although TFR has a greater influence on population growth rate than these two other components. TFR is more strongly correlated with DTI than r-var even though TFR and r-var are both highly and negatively correlated with DTI. GII is negatively correlated with both World Values Survey dimensions (Traditional-Rational and Survival-Self-Expression), indicating that more traditional societies and those focused on survival issues tend to have higher levels of gender inequality.

**Table 1** provides the foundation for developing the country typology employed to examine the dynamics of the Mortality Sex Ratio (MSR) and the Indirect Gender Inequality Index (IGII).

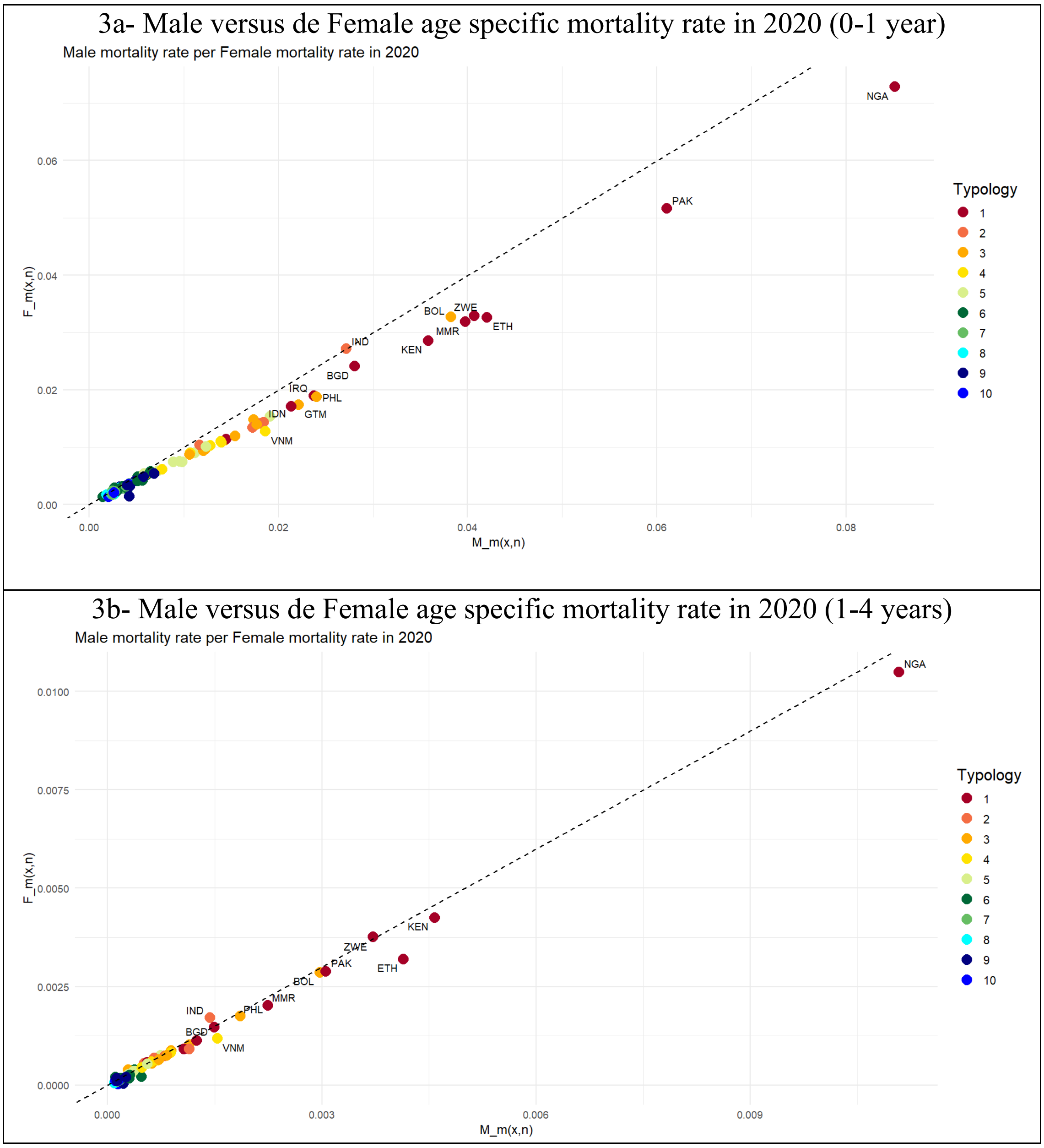
***Profiles of the MSR by age groups***

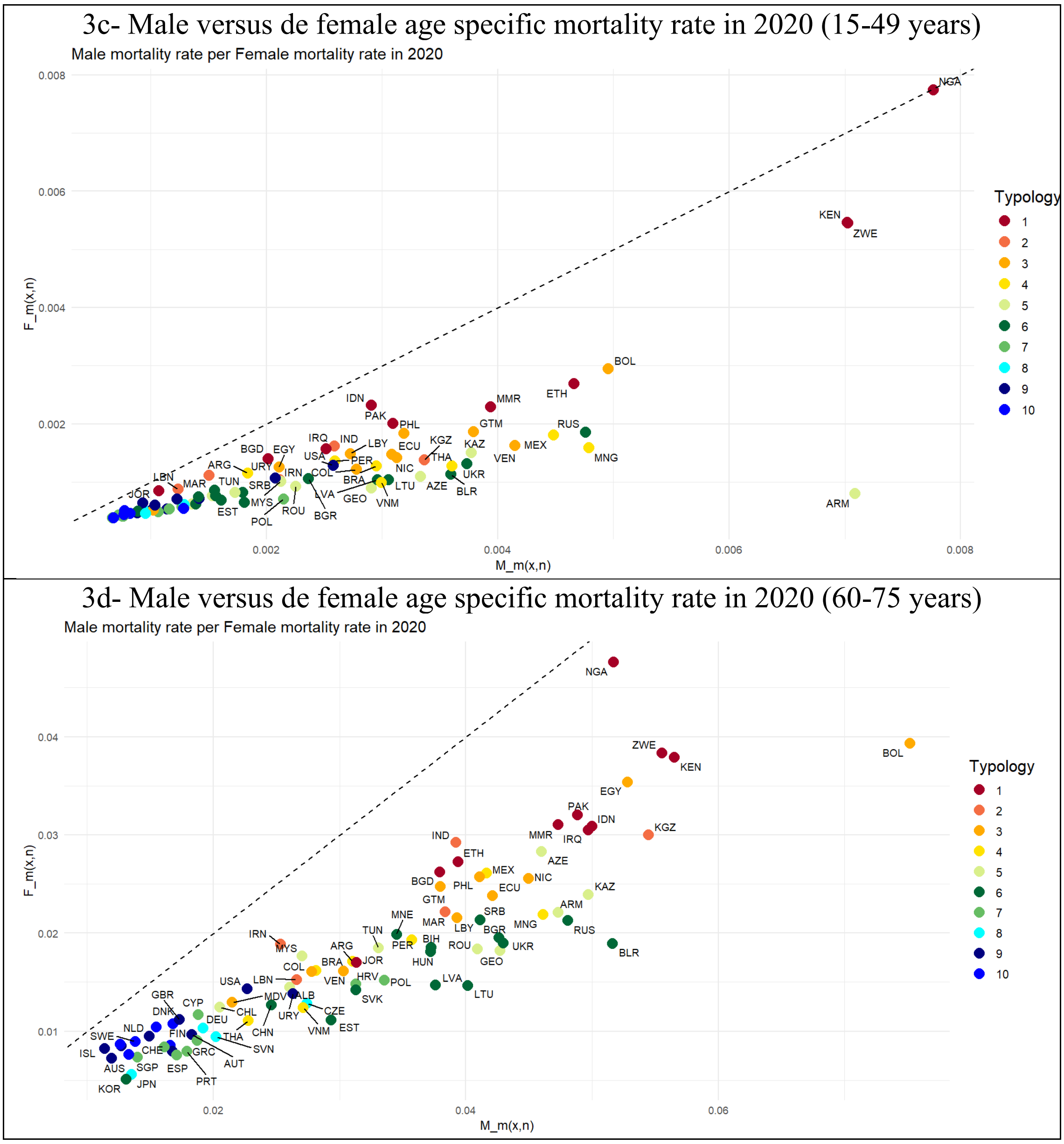
The results in this section are analysed across four age groups (less than 1, 1-4, 15-49, and 60-74 years) and compared with one another, always considering the typology of countries encompassing the seven variables implicit in the clusters definition. The aim of this comparison is to understand the dynamic of MSR, when analysed through life expectation at birth and the countries typology, studying the causes of your behaviour.

**Figure 3** presents the association between male and female age specific mortality rate for the four age-groups by the country typology in 2020. As expected, there is a clearer association when younger ages are considered and in general terms, being mortality higher among men than woman (with values below de diagonal line). The darker points (tones of blue) correspond to the more developed countries, and the red and orange points, the least developed countries. The yellow and green points represent the developing countries. The mortality sex differences paradox, in both maximum or minimum mortality levels situation, when MSR is located near 1.0 is clear in the **Figure 3**, because least developed and more developed countries present MSR closer to 1. In the first case because highest risk of death saves no lives regardless of sex, and in the second case, because lowest risk does save lives regardless of sex.

**Figures 3a** and **3b** highlight India as a country with higher female mortality than male mortality, contradictory to what is expected, suggesting that gender inequality in India impacts women's life expectancy. The disparity may stem from a preference for boys, leading to neglect of girls in early childhood, resulting in deaths from diarrhoea, malnutrition, or external causes (Alkema et al., 2014 and Marphatia, 2016). Female mortality being slightly lower than male mortality may also indicate gender inequality, according to a literature review, in the first two age-groups (Vallin, 2004). It is the case of Pakistan and Bolivia in **figure 3b**. In **figure 3a**, Pakistan and Nigeria presents the highest level of less than 1 year old death, where die much more boys than girls. At adult ages, (**Figures 3c** and **3d**) excepting Nigeria, where mortality is similar within sexes, male mortality is generally higher at ages 15-49, mainly due to higher levels of violence. Developing countries usually present higher male mortality rates per external causes as Brazil. At the older age group, the male mortality is much higher than female´s, probably due to lower demand for medical care, caused by a sexist culture (Oksuzyan et al., 2008). At adult ages (15 or more) association of male and female mortality follows a positive exponential shape, clearer at the oldest age group (**Figure 3d**).

**FIGURE 3** – Male versus Female Age specific Mortality ratio according to Country Typology Classification






Source: Prepared by the authors based on data from World Population Prospects (2024), World Values Survey (2017-2020, wave 7) and United Nations.

**Figure 4** displays variation of the MSR (y-axis) according to $E_0$ (x-axis). The green line represents the trend, while the red dotted line signals equal male and female mortality level. To estimate the trend, it was used a non-linear exponential model. Blue points represent developed countries; red and orange points indicate the least developed ones and yellow and green points represents the developing countries. The figure shows that, in general, MSR increases as $E_0$ does, with this trend being more pronounced at older age groups.

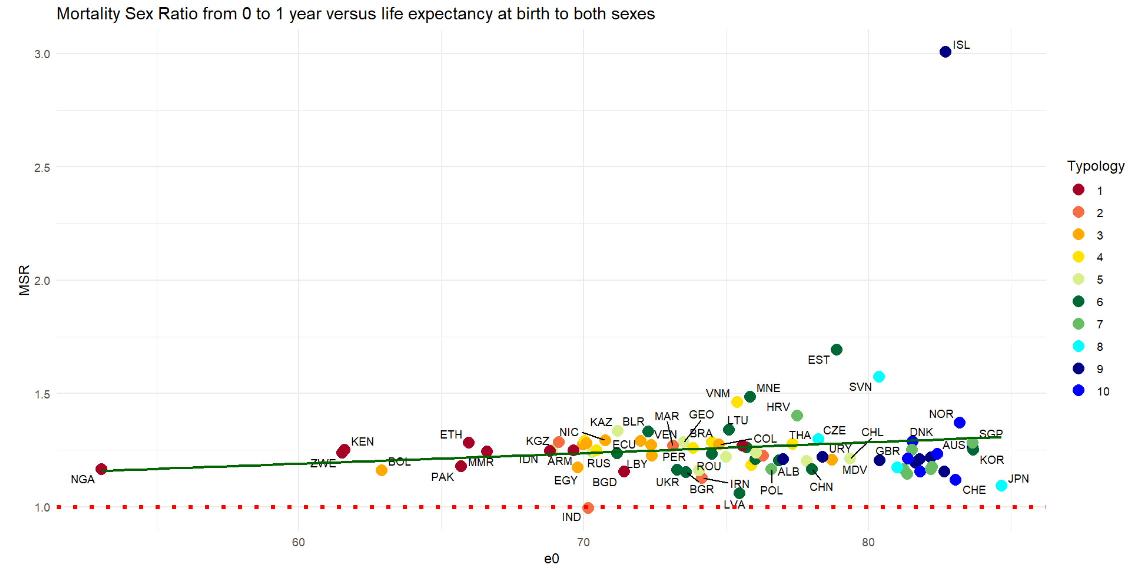
In **Figure 4a e 4b**, at early ages, 98,78% (0-1) and 96,34% (1-4) of the countries have a MSR less than 2,0. MSR is close to 1, however, this is a concerning observation, particularly in the least developed countries where gender inequality is more prevalent and happens de preference for sex in a more explicit way. On the other hand, however, slightly higher values of MSR are often among more developed countries suggesting that gains on $E_0$ would benefit, proportionally more boys than girls.

At ages 15-49 years, MSR reach, in general, higher values than those at earlier ages (**Figure 4c**). Except for Armenia, considered an outlier, 50% of the countries have a MSR below 2, which is close to 1 for countries like Bangladesh, Kenya, Indonesia, Marocco, Nigeria and Zimbabwe, while it is expected to have MSR well above 1,0 at this age group. Coincidentally these countries present significant gender inequality. At ages 60–75, MSR also increases as $E_0$ does (**Figure 4d**) and 30.49% of the observations present an MSR greater than 2. An outlier in this case is, once again, Nigeria, which shows comparatively low values for both $E_0$ and MSR. It is probably due to high levels of violence against men and women.

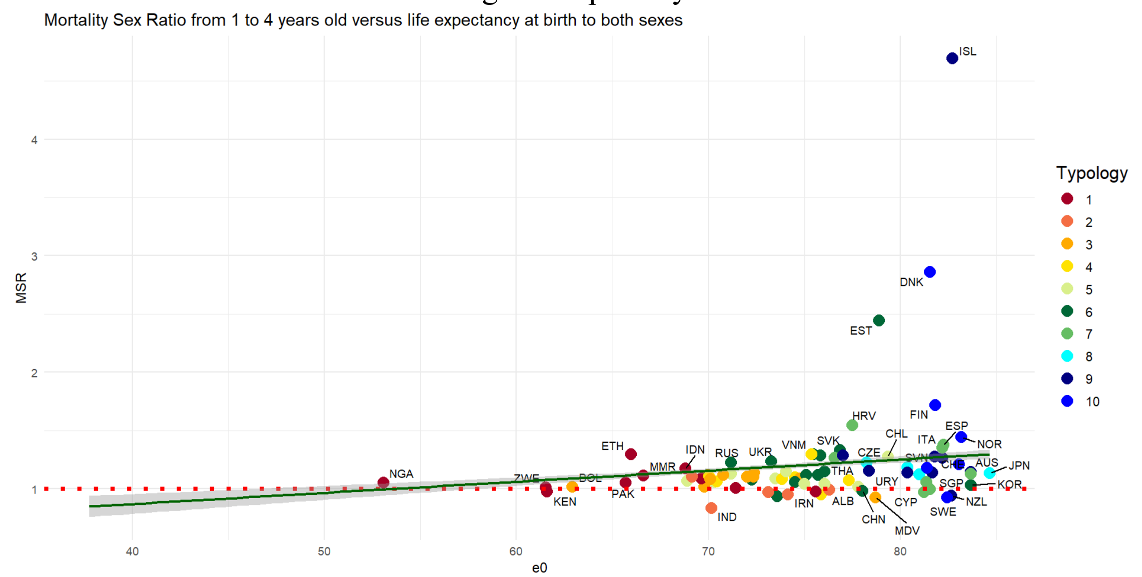
In summary (**Figure 4 and Appendix 4**), knowing that more developed countries have the highest $E_0$, are more advanced in the demographic transition and have better levels of gender equality, their MSR are closer or under 1, than most of developing countries, for the four age groups. Also, the least developed countries, with lower levels of $E_0$ and great gender inequality have their MSR closer to 1. The developing countries in general, have higher MSR.

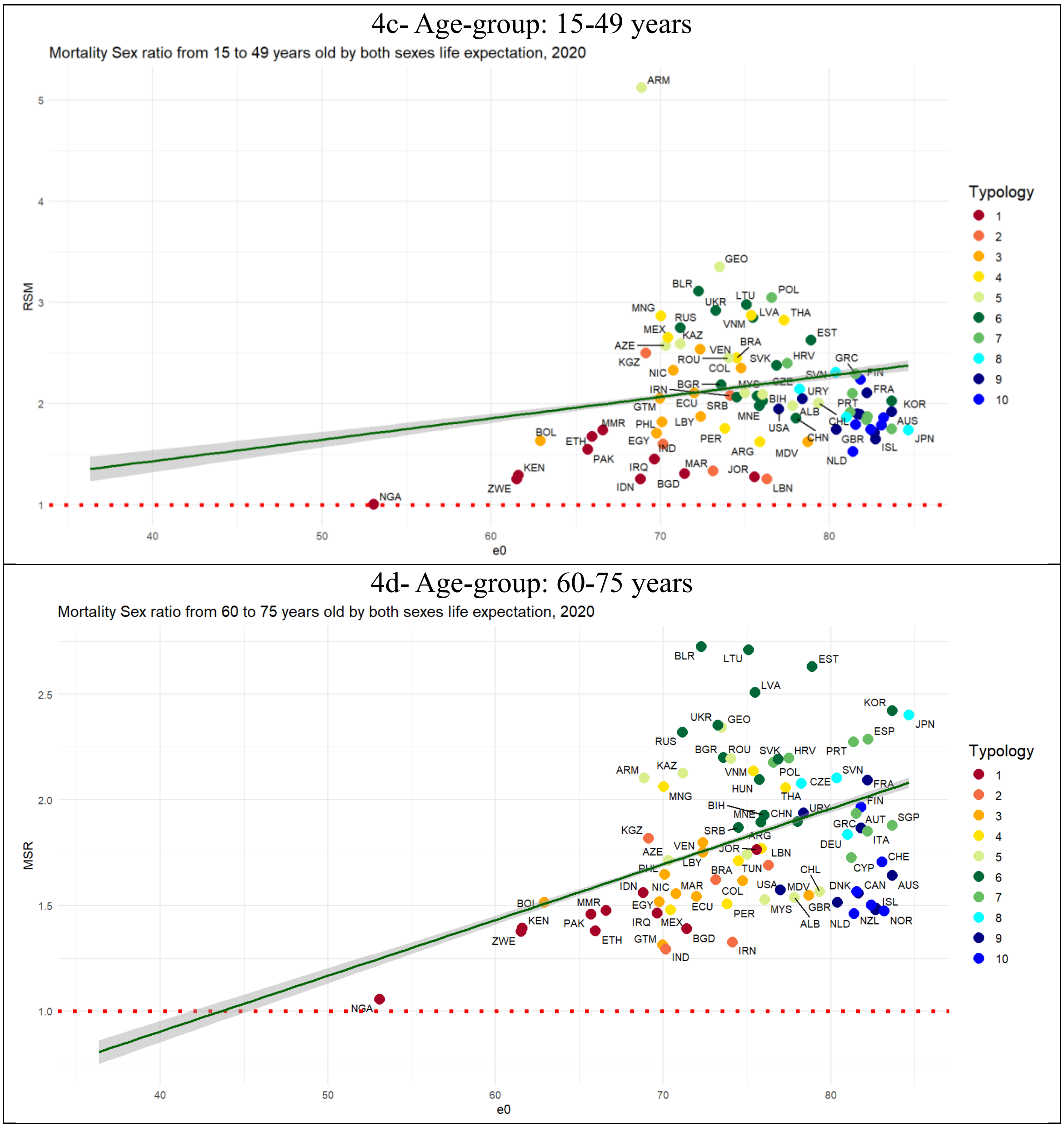
**FIGURE 4**- Mortality Sex Ratio per life expectancy according to Country Typology Classification, 2020

4a- Age-Group: 0-1




4b- Age-Group: 1-4 years

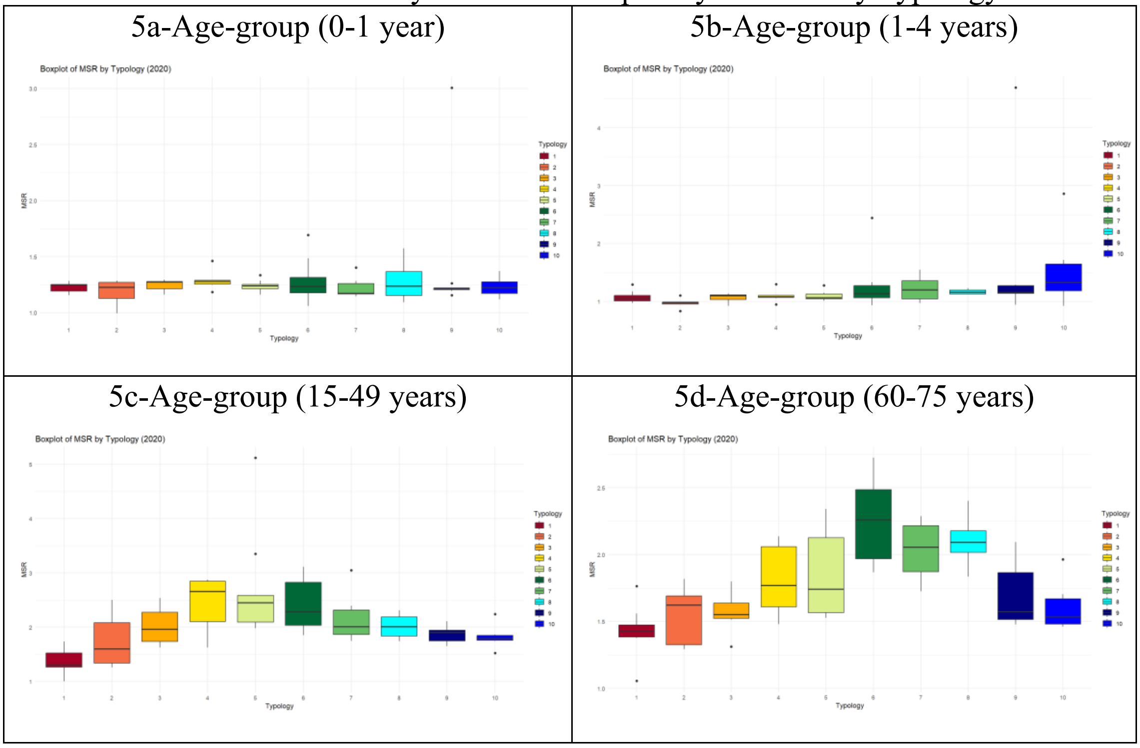





Source: Prepared by the authors based on data from World Population Prospects (2024), World Values Survey (2017-2020, wave 7) and United Nations.

**Figure 5** illustrates the heterogeneity of the Mortality Sex Ratio within each cluster, showing small heterogeneity between clusters from earlier ages (Figure 6a and 6b), which facilitates the purpose of estimating the IGII. The adult and the elderly age group (5c and 5d) exhibits the highest heterogeneity, which carries a heterogeneity to the IGII, hindering this study´s analysis.

**FIGURE 5**- Mortality Sex Ratio Boxplot by the Country Typology




Source: Prepared by the authors based on data from World Population Prospects (2024), World Values Survey (2017-2020, wave 7) and United Nations.

The Indirect Gender Inequality Index (IGII) was estimated following the methodology previously described, based on the distance between the theoretical reference point - defined by the median relationship between MSR and $E_0$ among the most developed countries, defined by the cluster 10 (see Figure 1 and Figure 4 and Table 2) - and each country depicted in Figure 4 and Table 2, calculated by age group.

**Table 2-** Indirect Gender Inequality Index by country, 2020

| Country | Code | Typology | IGII_0a1 | IGII_1a4 | IGII_15a49 | IGII_60a74 |
|---|---|---|---|---|---|---|
| Azerbaijan | AZE | 5 | 12,07 | 12,07 | 12,09 | 12,07 |
| Albania | ALB | 5 | 4,56 | 4,56 | 4,56 | 4,56 |
| Armenia | ARM | 5 | 13,49 | 13,49 | 13,89 | 13,50 |
| Argentina | ARG | 4 | 6,50 | 6,51 | 6,51 | 6,50 |
| Australia | AUL | 9 | 1,29 | 1,29 | 1,29 | 1,28 |
| Austria | AUS | 9 | 0,58 | 0,58 | 0,58 | 0,63 |
| Bangladesh | BNG | 1 | 10,96 | 10,96 | 10,97 | 10,96 |
| Bosnia and Herzegovina | BOS | 6 | 6,34 | 6,34 | 6,34 | 6,35 |
| Bolivia | BOL | 3 | 19,47 | 19,48 | 19,47 | 19,47 |
| Myanmar | MYA | 1 | 15,77 | 15,77 | 15,77 | 15,77 |
| Belarus | BLR | 6 | 10,11 | 10,11 | 10,19 | 10,17 |
| Brazil | BRA | 4 | 7,87 | 7,88 | 7,90 | 7,87 |

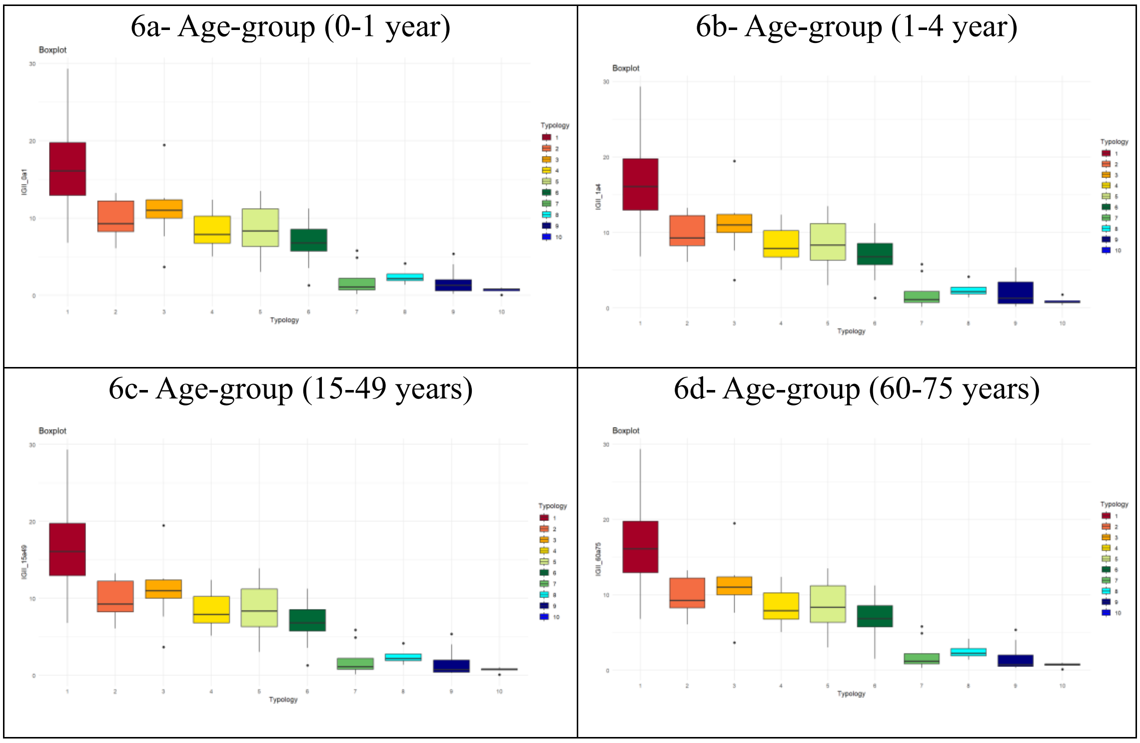
| | | | | | | |
|---|---|---|---|---|---|---|
| Bulgaria | BUL | 6 | 8,78 | 8,79 | 8,79 | 8,80 |
| Canada | CAN | 9 | 0,73 | 0,74 | 0,73 | 0,73 |
| China | CHN | 6 | 4,36 | 4,37 | 4,36 | 4,37 |
| Chile | CHL | 5 | 3,03 | 3,03 | 3,04 | 3,03 |
| Colombia | COL | 3 | 7,62 | 7,63 | 7,64 | 7,62 |
| Cyprus | CYP | 7 | 1,15 | 1,19 | 1,15 | 1,15 |
| Denmark | DEN | 10 | 0,84 | 1,78 | 0,83 | 0,84 |
| Ecuador | ECU | 3 | 10,38 | 10,38 | 10,38 | 10,38 |
| Egypt | EGY | 3 | 12,59 | 12,59 | 12,59 | 12,59 |
| Estonia | EST | 6 | 3,52 | 3,67 | 3,58 | 3,63 |
| Ethiopia | ETH | 1 | 16,41 | 16,41 | 16,41 | 16,41 |
| Czechia | CZR | 8 | 4,14 | 4,14 | 4,15 | 4,17 |
| Finland | FIN | 10 | 0,56 | 0,70 | 0,69 | 0,66 |
| France | FRN | 9 | 0,18 | 0,18 | 0,33 | 0,51 |
| Georgia | GRG | 5 | 8,87 | 8,87 | 9,00 | 8,90 |
| Germany | GMY | 8 | 1,38 | 1,39 | 1,38 | 1,39 |
| Greece | GRC | 7 | 0,85 | 0,89 | 0,96 | 0,90 |
| Guatemala | GUA | 3 | 12,41 | 12,41 | 12,41 | 12,41 |
| Croatia | BOL | 7 | 4,89 | 4,89 | 4,92 | 4,92 |
| Hungary | HUN | 6 | 6,65 | 6,65 | 6,65 | 6,67 |
| Iceland | ICE | 9 | 1,83 | 3,42 | 0,38 | 0,36 |
| Indonesia | INS | 1 | 13,56 | 13,56 | 13,58 | 13,56 |
| India | IND | 2 | 12,23 | 12,23 | 12,23 | 12,23 |
| Iran | IRN | 2 | 8,24 | 8,25 | 8,24 | 8,24 |
| Italy | ITA | 7 | 0,20 | 0,21 | 0,20 | 0,30 |
| Iraq | IRQ | 1 | 12,73 | 12,73 | 12,73 | 12,73 |
| Japan | JPN | 8 | 2,29 | 2,30 | 2,29 | 2,42 |
| Jordan | JOR | 1 | 6,80 | 6,80 | 6,82 | 6,80 |
| Kenya | KEN | 1 | 20,78 | 20,79 | 20,79 | 20,79 |
| Kyrgyzstan | KYR | 2 | 13,24 | 13,25 | 13,26 | 13,25 |
| Republic of Korea | ROK | 6 | 1,30 | 1,32 | 1,31 | 1,52 |
| Kazakhstan | KZK | 5 | 11,19 | 11,19 | 11,21 | 11,20 |
| Lebanon | LEB | 2 | 6,08 | 6,09 | 6,11 | 6,08 |
| Latvia | LAT | 6 | 6,90 | 6,90 | 6,98 | 6,96 |
| Lithuania | LIT | 6 | 7,28 | 7,28 | 7,36 | 7,36 |
| Slovakia | SLO | 6 | 5,52 | 5,52 | 5,54 | 5,55 |
| Libya | LIB | 3 | 9,99 | 9,99 | 9,99 | 9,99 |
| Mongolia | MON | 4 | 12,35 | 12,35 | 12,39 | 12,36 |
| Morocco | MOR | 2 | 9,25 | 9,25 | 9,26 | 9,25 |
| Maldives | MAD | 3 | 3,67 | 3,69 | 3,67 | 3,67 |
| Montenegro | MNG | 6 | 6,54 | 6,53 | 6,53 | 6,54 |
| Mexico | MEX | 4 | 11,93 | 11,93 | 11,96 | 11,93 |
| Malaysia | MAL | 5 | 6,32 | 6,33 | 6,33 | 6,32 |
| Nigeria | NIG | 1 | 29,31 | 29,31 | 29,32 | 29,31 |
| Netherlands | NTH | 10 | 0,99 | 0,99 | 1,03 | 1,00 |
| Norway | NOR | 10 | 0,83 | 0,83 | 0,82 | 0,83 |
| Nicaragua | NIC | 3 | 11,61 | 11,62 | 11,62 | 11,61 |
| New Zealand | NEW | 9 | 0,29 | 0,45 | 0,31 | 0,32 |

| | | | | | | |
|---|---|---|---|---|---|---|
| Peru | PER | 4 | 8,55 | 8,55 | 8,55 | 8,55 |
| Pakistan | PAK | 1 | 16,68 | 16,68 | 16,68 | 16,68 |
| Poland | POL | 7 | 5,79 | 5,79 | 5,91 | 5,81 |
| Portugal | POR | 7 | 1,02 | 1,04 | 1,05 | 1,21 |
| Romania | ROM | 5 | 8,33 | 8,34 | 8,36 | 8,35 |
| Philippines | PHI | 3 | 12,28 | 12,28 | 12,28 | 12,28 |
| Russian Federation | RUS | 6 | 11,21 | 11,21 | 11,25 | 11,23 |
| Slovenia | SLV | 8 | 2,05 | 2,02 | 2,07 | 2,07 |
| Singapore | SIN | 7 | 1,28 | 1,29 | 1,28 | 1,31 |
| Spain | SPN | 7 | 0,14 | 0,16 | 0,14 | 0,68 |
| Serbia | SRB | 6 | 7,87 | 7,88 | 7,88 | 7,88 |
| Sweden | SWD | 10 | 0,05 | 0,37 | 0,10 | 0,13 |
| Switzerland | SWZ | 10 | 0,69 | 0,69 | 0,68 | 0,69 |
| Thailand | THI | 4 | 5,05 | 5,05 | 5,15 | 5,07 |
| Tunisia | TUN | 5 | 7,38 | 7,38 | 7,38 | 7,38 |
| United Kingdom | UK-GBR | 9 | 2,00 | 2,00 | 2,00 | 2,00 |
| Ukraine | UKR | 6 | 9,10 | 9,10 | 9,16 | 9,13 |
| United States of America | USA | 9 | 5,37 | 5,37 | 5,37 | 5,37 |
| Uruguay | URU | 9 | 4,00 | 4,00 | 4,00 | 4,01 |
| Venezuela | VEN | 3 | 10,01 | 10,01 | 10,04 | 10,01 |
| Viet Nam | DRV | 4 | 7,00 | 7,00 | 7,07 | 7,02 |
| Zimbabwe | ZIM | 1 | 20,85 | 20,85 | 20,86 | 20,85 |

Source: Prepared by the authors based on data from World Population Prospects (2024), World Values Survey (2017-2020, wave 7) and United Nations.

**Figure 6** presents boxplots of the Indirect Gender Inequality Index by Country Typology across the four age groups studied. A significant decrease in gender inequality is observed from Cluster 6 to Cluster 7. Cluster 6 comprises countries like Russia, China, South Korea, and Eastern Europe, while Cluster 7 includes Spain, Greece, Italy and Portugal. The first 6 clusters present high levels of gender inequality, especially the cluster 1, which includes Bangladesh, Nigeria and Pakistan.

**FIGURE 6**– Indirect Gender Inequality Index by the Country Typology Classification and Age-Group




Source: Prepared by the authors based on data from World Population Prospects (2024), World Values Survey (2017-2020, wave 7) and United Nations.

## DISCUSSION

The findings support the conclusions of Alkema et al. (2014), who argued that decreasing mortality was associated with increasing MSR, except at very low infant mortality, where sex ratios decreased with total mortality. Related to under-5 sex ratios the authors identified, for 2012, 15 outlier countries, of which ten (Afghanistan, Bahrain, Bangladesh, China, Egypt, India, Pakistan, Iran, Jordan, and Nepal) had female mortality higher than expected. Alkema et al. (2014) results support the findings from this study, which indicate that in least developed countries, where overall mortality is high, the Mortality Sex Ratio (MSR) tends to be bigger or equal to one - reflecting gender inequalities that disproportionately affect female survival, in places where the mortality is high.

Drevenstedt et al. (2008) and Wong et al. (2021) found that the MSR follows a bell-shaped curve for infant age groups, indicating that despite extreme variations in mortality, countries tend to exhibit similar MSR levels. This study establishes a relationship between mortality sex ratio and life expectancy at birth and proposes a new gender inequality index for a sample of 82 countries in 2020. This approach is made possible by the varying stages of human development and of demographic transition, across countries, eliminating the immediate need for a temporal analysis, as conducted by Drevenstedt et al. (2008) and Wong et al. (2021). This study found that for least developed countries and developed countries the MSR is close to 1, tending to be a little bit lower than one. In developing countries this study found that the MSR is higher than 1.

Vallin (2004) conducted a literature review on mortality by sex and gender, tracing the historical evolution of mortality over time, particularly in the context of the Mortality Transitions. The insights from Vallin's study, along with the findings of Alkema et al. (2014), Drevenstedt et al. (2008), and Wong et al. (2021), contributed to the formulation of the hypothesis proposed in this study.

In the pre-transitional period of very high mortality rates and significant gender inequality, the gender differential in mortality is expected to be relatively low, regardless of the age of death, since the causes of death, which are essentially exogenous, would affect men and women practically without distinction. In a later scenario, still at the beginning of the transition, when some infectious causes of death dominate and infant mortality is consequently reduced, and gender inequality is still high, there would often be relatively higher mortality among girls associated to the greater social value given to boys; in the adult age group, there would be an occasional excess female mortality, with maternal causes of death playing an important role. Subsequently, in a transitional scenario of falling adult female mortality, there would be large excess male adult mortality in some populations due to the incidence of external causes among men and, consequently, a smaller differentiation by sex. In the low mortality stage and beginning of the second demographic transition, there may be a decrease in the differences between male and female mortality levels for all age groups.

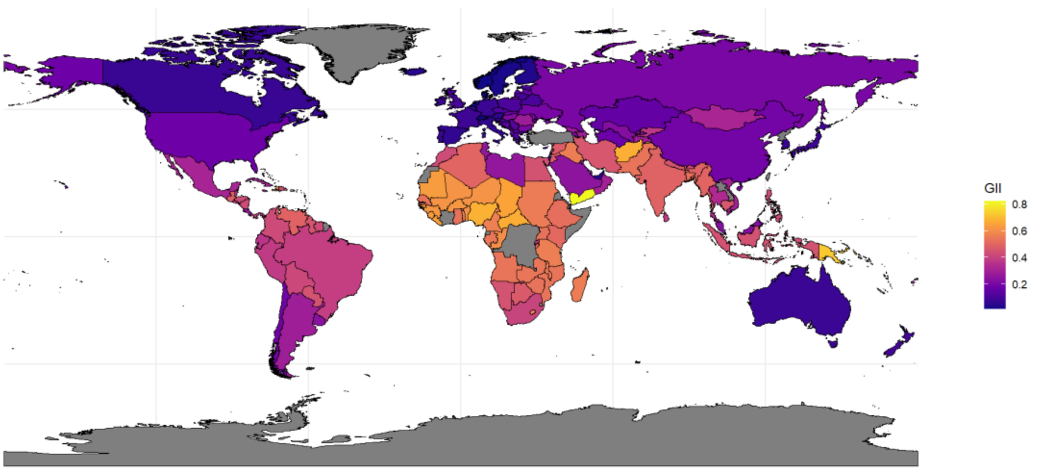
All these theories permitted the estimation of the **Indirect Gender Inequality Index (IGII)**. In this study, the **IGII** was constructed for the four age groups analysed. However, the results were very similar across all groups, producing identical outcomes when compared on a map **(Appendix 4**). Therefore, only one map was chosen to represent the IGII 2020.

According to **Figure 7**, the Gender Inequality Index (GII) provides broader coverage, including more countries, than the Indirect Gender Inequality Index (IGII).

However, the IGII is more sensitive. In Europe the IGII seems to differentiate more the gender inequality between the countries, because the IGII map present more colours in this region. When we look at Russia, China and USA, there are more colours in the IGII map than in GII map. IGII presents lower gender inequality when we compare Brazil, Peru, Argentina, Uruguay, Chile, and Mexico in both maps. The IGII considers all the private and public dimensions of gender inequality, that may lead to the death, while GII considers just a few dimensions to represent the private and public gender inequality.

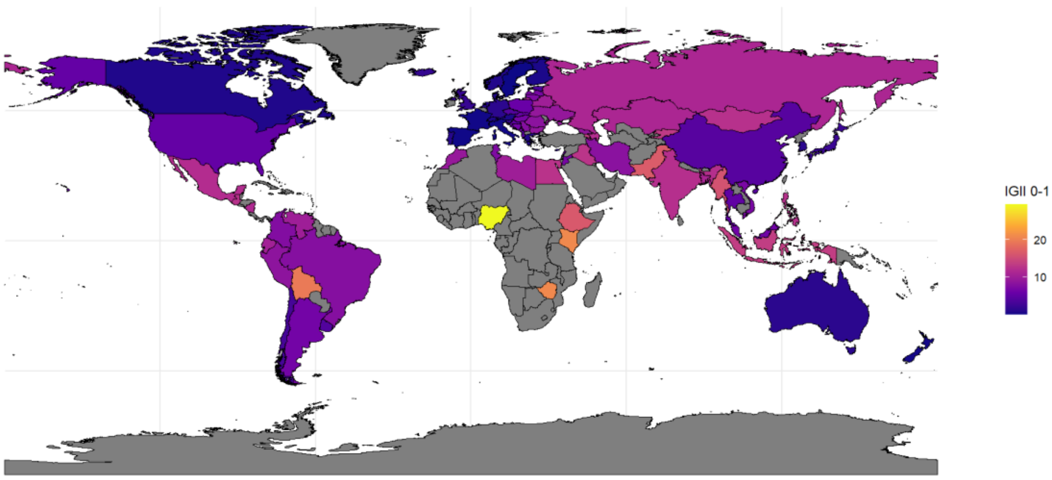
**FIGURE 7- Gender Inequality Indexes Maps (GII and IGII)**

**7a- GENDER INEQUALITY INDEX MAP**




Source: Prepared by the authors, based on Gender Inequality Index (GII) from United Nations.

**7b- INDIRECT GENDER INEQUALITY INDEX MAP**




Source: Prepared by the authors, based on data from World Population Prospects (2024), World Values Survey (2017-2020, wave 7) and United Nations.

One key advantage of the IGII is its ability to capture broader dimensions of gender inequality, such as gender-based violence, unpaid work, and social discrimination, which the GII omits. Like the GII, the IGII depends on national data, which may be incomplete or inconsistent. However, the IGII incorporates cultural differences across countries, though it still fails to address intra-country inequalities like race or class disparities. Unlike the GII, the IGII places less emphasis on female disadvantages, as it uses the Mortality Sex Ratio (MSR) as a primary indicator, ensuring a more balanced perspective on gender disparities.

## CONCLUSION

This paper confirms findings proposed by Vallin (2004), Alkema et al. (2014), Drevenstedt et al. (2008) and Wong et al. (2021) and show a different view about their topic. This study shows the relation between the different stages of demographic transition and different levels of human development across countries, in cartesian plan (constructed by the Mortality Sex Ratio (MSR) and life expectancy at birth ($E_0$)), allowing the estimation of the **Indirect Gender Inequality Index (IGII)**.

But also presents an alternative way to measure gender inequality and to compare countries. The **Indirect Gender Inequality Index (IGII)** seems to be more sensible and differentiate better Asia and South America and puts China, Japan, Chile and Uruguay in positions more fare in the world context. Russia, Mongolia and Kazakhstan are better described using the IGII. When used the country typology, the gender inequality is very similar from cluster 2, 3, 4, 5 and 6. The first cluster presents higher gender inequality than the others. However, the **IGII** contributes to include Russia and part of East Europe as places where the public policies to improve gender equality are necessary.

The main advantage of this study is the inclusion of many countries, although it remains smaller than those covered by the GII from the UN. Additionally, the study introduces a new methodology for estimating gender inequality, using basic data accessible to many countries. However, the primary limitation lies in the varying quality of data across countries, which may influence the results, especially in the older ages.

One limitation of this study is that it provides a schematic overview without delving into the specific cultural contexts of each society or the historical trajectories of individual countries. The populations of these countries are considered based on their average demographic behaviour, without accounting for internal social or cultural inequalities within each region. Another limitation is the reduction of gender issues to a heteronormative framework, since the data are classified exclusively by the biological dimension (sex). This approach overlooks, for instance, aspects such as violence against the LGBTQIA+ population. Furthermore, the study assumes that the Demographic Transition Theory represents a global trend.

The cluster model adopted in this study does not account for the pace of the demographic transition, which could be measured, for instance, by the change in total fertility rates between 1980 and 2020 or by the variation in life expectancy at birth over the same period. This pace is important, as some countries underwent a rapid demographic transition, distinguishing them from those where the process was slower and more gradual. Incorporating this dimension could be a valuable direction for future research.

It would be valuable to extend this research by analysing external causes of death and other externalities within specific age groups, as these are behaviour-related causes that may serve as additional indicators of gender inequality. Besides it is also valuable to test the hypothesis presented in the paper´s discussion.

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## Appendix 1 – Independent Countries recognized by United Nations (n=192) in alphabetical order

| | | |
|---|---|---|
| Afghanistan | France | North Macedonia |
| Albania | Gabon | Norway |
| Algeria | Gambia | Oman |
| Andorra | Georgia | Palau |
| Angola | Germany | Palestine |
| Antigua and Barbuda | Ghana | Panama |
| Argentina | Greee | Papua New Guinea |
| Armenia | Grenada | Paraguay |
| Australia | Guatemala | Peru |
| Austria | Guinea | Philippines |
| Azerbaijan | Guyana | Poland |
| Bahamas | Haiti | Portugal |
| Bahrain | Honduras | Qatar |
| Bangladesh | Hungary | Romania |
| Barbados | Iceland | Russian Federation |
| Belarus | India | Rwanda |
| Belgium | Indonesia | Saint Kitts and Nevis |
| Belize | Iran | Saint Lucia |
| Benin | Iraq | Saint Vicent and Grenadines |
| Bhutan | Ireland | Samoa |
| Bolivia | Israel | San Marino |
| Bosnia and Herzegovina | Italy | Sao Tome and Principe |
| Botswana | Jamaica | Saudi Arabia |
| Brazil | Japan | Senegal |
| Brunei | Jordan | Serbia |
| Bulgaria | Kazakhstan | Seychelles |
| Burkina Faso | Kenya | Sierra Leone |
| Bermuda | Kiribati | Singapore |
| Burundi | Korea (Republic of) | Mexico |
| Cabo Verde | Kuwait | Slovakia |
| Cambodia | Kyrgyzstan | Slovenia |
| Cameroon | Lao | Solomon Islands |
| Canada | Lativia | South Sudan |
| Central African Republic | Lebanon | Spain |
| Chad | Lesotho | Sri Lanka |
| Chile | Liberia | Sudan |
| China | Libya | Suriname |
| Colombia | Liechtenstein | Sweden |
| Comoros | Lithuania | Switzerland |
| Congo | Luxembourg | Syrian Arab Republic |
| Solomon Islands | Madagascar | Tajikistan |
| Costa Rica | Malawi | Tanzania |
| Côte d´lvoire | Malaysia | Thailand |

| | | |
|---|---|---|
| Croatia | Maldives | Timor-Leste |
| Cuba | Mali | Togo |
| Cyprus | Malta | Tonga |
| Czechia | Marshall Islands | Trinidad and Tobago |
| Denmark | Mauritania | Tunisia |
| Djibouti | Mauritius | Turkiye |
| Dominica | Mexico | Turkmenistan |
| Dominican Republic | micronesia | Tuvalu |
| Ecuador | Maldova | uganda |
| Egypt | Mongolia | Ukraine |
| El Salvador | Montenegro | United Arab Emirates |
| Equatorial Guinea | Marocco | United Kingdom |
| Egypt | Mozambique | United States |
| El Salvador | Myanmar | Uruguay |
| Equatorial Guinea | Namibia | Uzbekistan |
| Eritrea | Nepal | Vanuatu |
| Estonia | Netherlands | Venezuela |
| Eswatini | New Zealand | Viet Nan |
| Ethiopia | Nicaragua | Yemen |
| Fiji | Niger | Zambia |
| Finland | Nigeria | Zimbabwe |

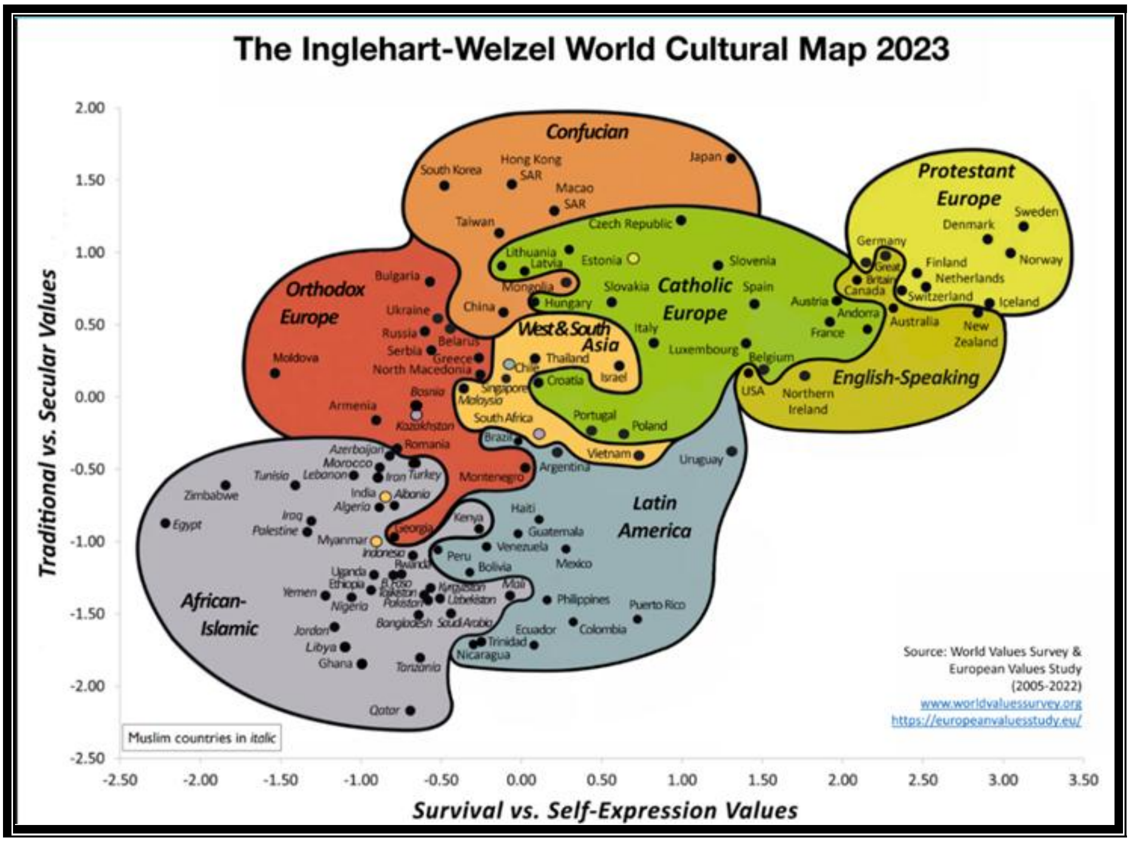
**Source:** United Nations, 2020

## Appendix 2 – 82 Included countries in Analysis

| Country | CODE | Country | CODE |
|---|---|---|---|
| Azerbaijan | AZE | Kyrgyzstan | KYR |
| Albania | ALB | South Korea | ROK |
| Armenia | ARM | Kazakhstan | KZK |
| Argentina | ARG | Lebanon | LEB |
| Australia | AUL | Latvia | LAT |
| Austria | AUS | Lithuania | LIT |
| Bangladesh | BNG | Slovakia | SLO |
| Bosnia and Herzegovina | BOS | Libya | LIB |
| Bolivia | BOL | Mongolia | MON |
| Myanmar (Burma) | MYA | Morocco | MOR |
| Byelarus | BLR | Maldives | MAD |
| Brazil | BRA | Montenegro | MNG |
| Bulgaria | BUL | Mexico | MEX |
| Canada | CAN | Malaysia | MAL |
| China | CHN | Nigeria | NIG |
| Chile | CHL | Netherlands | NTH |
| Colombia | COL | Norway | NOR |
| Cyprus | CYP | Nicaragua | NIC |
| Denmark | DEN | New Zealand | NEW |
| Ecuador | ECU | Peru | PER |
| Egypt | EGY | Pakistan | PAK |
| Estonia | EST | Poland | POL |
| Ethiopia | ETH | Portugal | POR |
| Czech Republic | CZR | Romania | ROM |
| Finland | FIN | Philippines | PHI |
| France | FRN | Russia | RUS |
| Georgia | GRG | Slovenia | SLV |
| Germany | GMY | Singapore | SIN |
| Greece | GRC | Spain | SPN |
| Guatemala | GUA | Serbia | SRB |
| Croatia | CRO | Sweden | SWD |
| Hungary | HUN | Switzerland | SWZ |
| Iceland | ICE | Thailand | THI |
| Indonesia | INS | Tunisia | TUN |
| India | IND | United Kingdom | UK-GBR |
| Iran | IRN | Ukraine | UKR |
| Italy | ITA | United States | USA |
| Iraq | IRQ | Uruguay | URU |
| Japan | JPN | Venezuela | VEN |
| Jordan | JOR | Vietnam | DRV |
| Kenya | KEN | Zimbabwe | ZIM |

**Source: United Nations, 2010**

## Appendix 3 – Inglehart-Welzel Cultural Map




"The cultural map methodology developed by the late WVSA Founder Ronald Inglehart and the WVSA Vice-President Christian Welzel asserts that there are two major dimensions of cross cultural variation in the world: *traditional values versus secular-rational values* and *survival values versus self-expression values*. The Inglehart-Welzel Cultural Map of the World illustrates that -despite many nuanced differences--human belief systems boil down to these two major dimensions of cross-cultural variation. The global cultural map shows how scores of societies are located on these two dimensions. The first dimension measures how important a role religious doctrine plays in societies, with secular values indicating a largely reduced role of organized religion. The second dimension, by contrast, indicates how autonomous from kinship obligations individuals in a society are in their life planning, with self-expression values emphasizing high individual autonomy. Consecutive waves of the World Values Survey from the early 1980s until today have replicated these two dimensions with astoundingly stable moral positions of countries and their larger culture zones to each other. Yet, there is also movement on the map: As populations become more prosperous, educated, live longer and give birth to fewer children, their descendants become more secular and self-expressive in their moral values, thus moving from the lower left to the upper right on the cultural map. Hence, despite enduring cultural differences, humanity as a whole is in the middle of an emancipatory moral progression." (https://www.worldvaluessurvey.org/WVSNewsShow.jsp?ID=467).
For more information: https://www.worldvaluessurvey.org/WVSContents.jsp?CMSID=findings

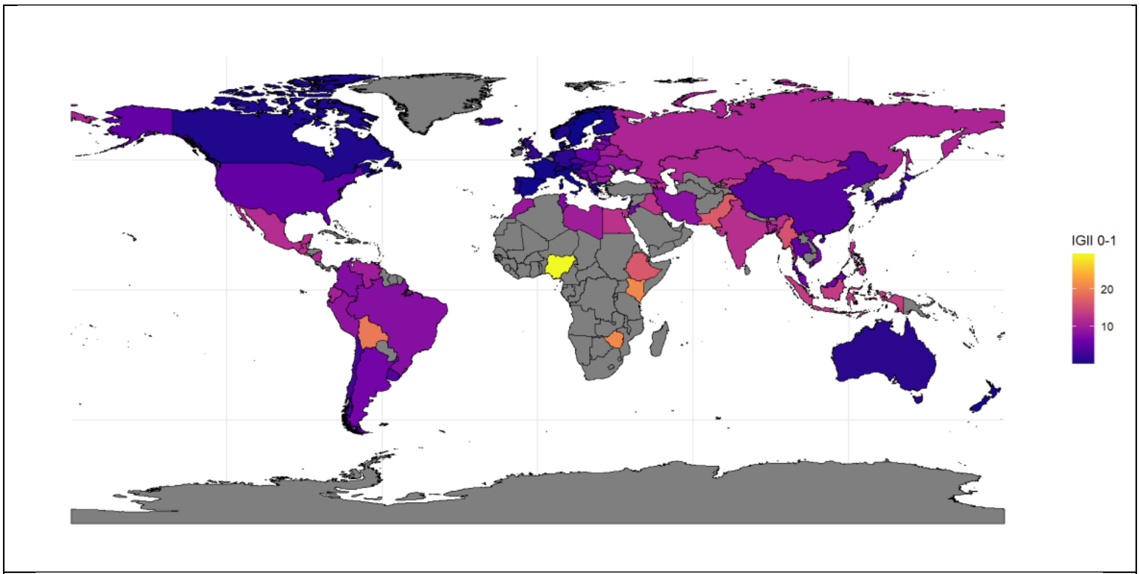
## Appendix 4 – Mortality Sex Ratio (MSR) and life expectancy at birth, 2020, by country

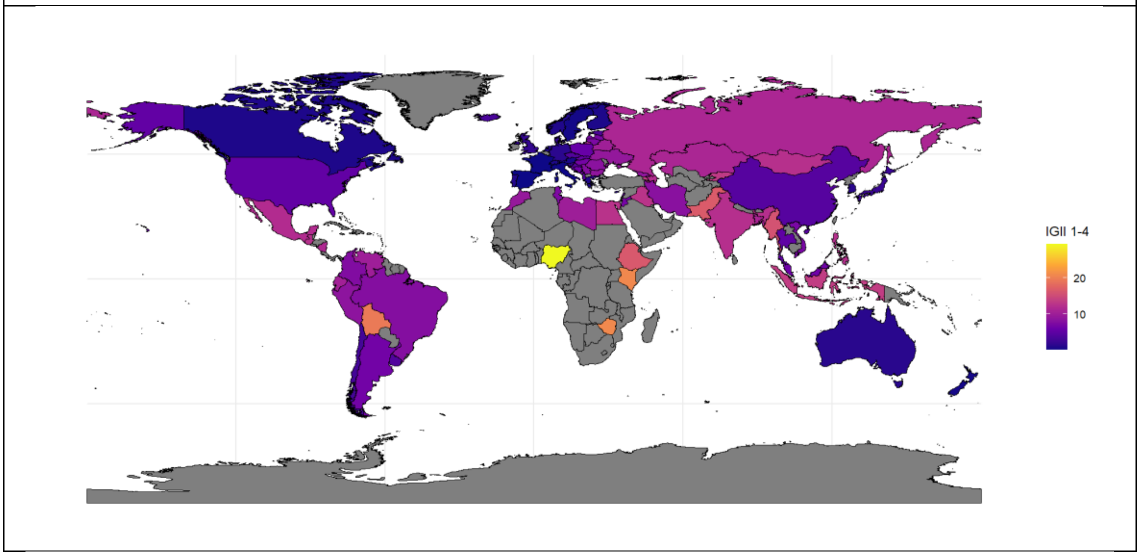
| Country | Code | Typology | MSR_ 0a1 | MSR_ 1a4 | MSR_ 15a50 | MSR_ 60a75 | e0 |
|---|---|---|---|---|---|---|---|
| Azerbaijan | AZE | 5 | 1,24 | 1,06 | 2,57 | 1,71 | 70,31 |
| Albania | ALB | 5 | 1,20 | 1,01 | 1,98 | 1,54 | 77,82 |
| Armenia | ARM | 5 | 1,25 | 1,06 | 5,12 | 2,10 | 68,89 |
| Argentina | ARG | 4 | 1,18 | 0,95 | 1,62 | 1,77 | 75,88 |
| Australia | AUL | 9 | 1,26 | 1,14 | 1,92 | 1,64 | 83,66 |
| Austria | AUS | 9 | 1,21 | 1,27 | 1,89 | 1,86 | 81,80 |
| Bangladesh | BNG | 1 | 1,16 | 1,01 | 1,31 | 1,39 | 71,42 |
| Bosnia and Herzegovina | BOS | 6 | 1,21 | 1,15 | 2,02 | 1,93 | 76,04 |
| Bolivia | BOL | 3 | 1,16 | 1,02 | 1,63 | 1,52 | 62,91 |
| Myanmar | MYA | 1 | 1,24 | 1,11 | 1,74 | 1,48 | 66,61 |
| Belarus | BLR | 6 | 1,33 | 1,08 | 3,11 | 2,72 | 72,27 |
| Brazil | BRA | 4 | 1,28 | 1,10 | 2,45 | 1,71 | 74,51 |
| Bulgaria | BUL | 6 | 1,15 | 0,93 | 2,19 | 2,20 | 73,60 |
| Canada | CAN | 9 | 1,19 | 1,14 | 1,90 | 1,56 | 81,65 |
| China | CHN | 6 | 1,17 | 0,98 | 1,86 | 1,90 | 78,02 |
| Chile | CHL | 5 | 1,21 | 1,28 | 2,01 | 1,57 | 79,35 |
| Colombia | COL | 3 | 1,27 | 1,09 | 2,35 | 1,62 | 74,76 |
| Cyprus | CYP | 7 | 1,16 | 0,97 | 1,91 | 1,73 | 81,23 |
| Denmark | DEN | 10 | 1,29 | 2,86 | 1,79 | 1,57 | 81,55 |
| Ecuador | ECU | 3 | 1,29 | 1,10 | 2,11 | 1,54 | 72,00 |
| Egypt | EGY | 3 | 1,17 | 1,01 | 1,71 | 1,52 | 69,79 |
| Estonia | EST | 6 | 1,69 | 2,44 | 2,63 | 2,63 | 78,89 |
| Ethiopia | ETH | 1 | 1,28 | 1,29 | 1,68 | 1,38 | 65,97 |
| Czechia | CZR | 8 | 1,30 | 1,23 | 2,14 | 2,08 | 78,24 |
| Finland | FIN | 10 | 1,16 | 1,72 | 2,24 | 1,96 | 81,82 |
| France | FRN | 9 | 1,22 | 1,26 | 2,11 | 2,09 | 82,20 |
| Georgia | GRG | 5 | 1,28 | 1,09 | 3,35 | 2,34 | 73,51 |
| Germany | GMY | 8 | 1,17 | 1,12 | 1,87 | 1,83 | 81,00 |
| Greece | GRC | 7 | 1,25 | 1,00 | 2,29 | 1,93 | 81,54 |
| Guatemala | GUA | 3 | 1,27 | 1,12 | 2,05 | 1,31 | 69,97 |
| Croatia | BOL | 7 | 1,40 | 1,55 | 2,40 | 2,20 | 77,50 |
| Hungary | HUN | 6 | 1,26 | 1,12 | 2,07 | 2,10 | 75,73 |
| Iceland | ICE | 9 | 3,01 | 4,69 | 1,65 | 1,49 | 82,71 |
| Indonesia | INS | 1 | 1,25 | 1,17 | 1,26 | 1,56 | 68,82 |
| India | IND | 2 | 0,99 | 0,84 | 1,60 | 1,29 | 70,16 |
| Iran | IRN | 2 | 1,13 | 0,95 | 2,08 | 1,32 | 74,14 |
| Italy | ITA | 7 | 1,16 | 1,35 | 1,84 | 1,85 | 82,18 |
| Iraq | IRQ | 1 | 1,25 | 1,09 | 1,45 | 1,46 | 69,65 |
| Japan | JPN | 8 | 1,09 | 1,13 | 1,74 | 2,40 | 84,67 |
| Jordan | JOR | 1 | 1,27 | 0,98 | 1,28 | 1,76 | 75,58 |
| Kenya | KEN | 1 | 1,25 | 0,97 | 1,29 | 1,39 | 61,60 |
| Kyrgyzstan | KYR | 2 | 1,28 | 1,10 | 2,50 | 1,82 | 69,14 |
| Republic of Korea | ROK | 6 | 1,25 | 1,03 | 2,02 | 2,42 | 83,68 |
| Kazakhstan | KZK | 5 | 1,33 | 1,13 | 2,59 | 2,13 | 71,20 |
| Lebanon | LEB | 2 | 1,23 | 0,99 | 1,26 | 1,69 | 76,30 |
| Latvia | LAT | 6 | 1,06 | 1,30 | 2,85 | 2,51 | 75,48 |

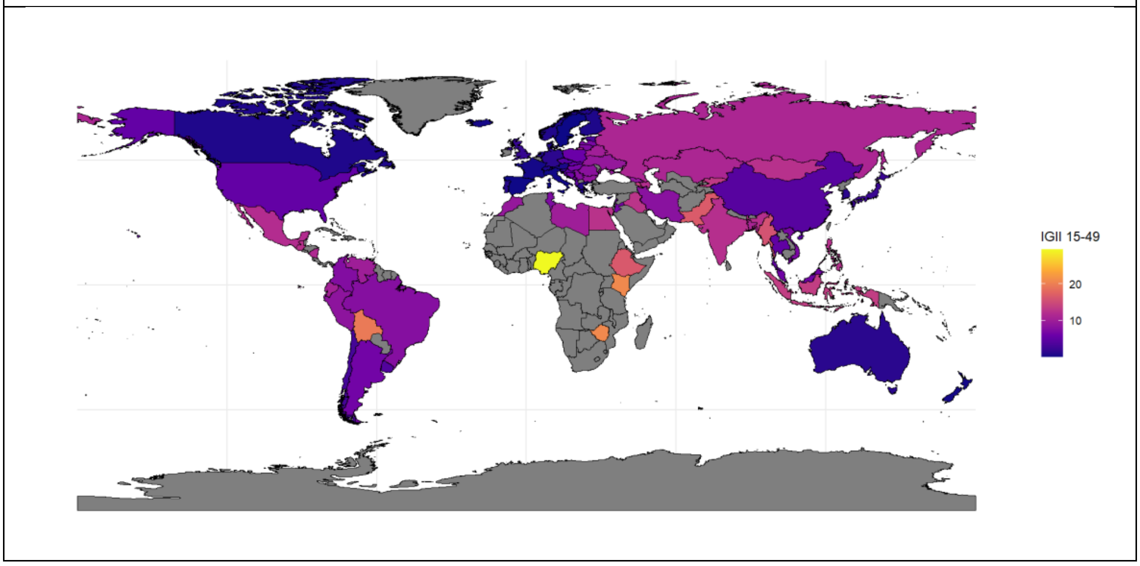
| | | | | | | | |
|---|---|---|---|---|---|---|---|
| Lithuania | LIT | 6 | 1,34 | 1,12 | 2,98 | 2,71 | 75,11 |
| Slovakia | SLO | 6 | 1,21 | 1,33 | 2,37 | 2,19 | 76,86 |
| Libya | LIB | 3 | 1,23 | 1,14 | 1,87 | 1,75 | 72,39 |
| Mongolia | MON | 4 | 1,29 | 1,11 | 2,87 | 2,06 | 70,03 |
| Morocco | MOR | 2 | 1,27 | 0,97 | 1,33 | 1,62 | 73,13 |
| Maldives | MAD | 3 | 1,21 | 0,93 | 1,62 | 1,55 | 78,71 |
| Montenegro | MNG | 6 | 1,49 | 1,28 | 1,98 | 1,89 | 75,85 |
| Mexico | MEX | 4 | 1,25 | 1,06 | 2,65 | 1,48 | 70,45 |
| Malaysia | MAL | 5 | 1,24 | 1,04 | 2,09 | 1,53 | 76,06 |
| Nigeria | NIG | 1 | 1,17 | 1,05 | 1,00 | 1,06 | 53,07 |
| Netherlands | NTH | 10 | 1,21 | 1,18 | 1,52 | 1,46 | 81,39 |
| Norway | NOR | 10 | 1,37 | 1,44 | 1,86 | 1,47 | 83,20 |
| Nicaragua | NIC | 3 | 1,29 | 1,12 | 2,33 | 1,56 | 70,77 |
| New Zealand | NEW | 9 | 1,15 | 0,94 | 1,71 | 1,48 | 82,66 |
| Peru | PER | 4 | 1,26 | 1,08 | 1,75 | 1,51 | 73,83 |
| Pakistan | PAK | 1 | 1,18 | 1,05 | 1,55 | 1,46 | 65,70 |
| Poland | POL | 7 | 1,17 | 1,27 | 3,05 | 2,18 | 76,60 |
| Portugal | POR | 7 | 1,14 | 1,06 | 2,10 | 2,27 | 81,37 |
| Romania | ROM | 5 | 1,16 | 1,15 | 2,45 | 2,20 | 74,05 |
| Philippines | PHI | 3 | 1,28 | 1,08 | 1,82 | 1,65 | 70,10 |
| Russian Federation | RUS | 6 | 1,24 | 1,22 | 2,75 | 2,32 | 71,17 |
| Slovenia | SLV | 8 | 1,57 | 1,19 | 2,31 | 2,10 | 80,36 |
| Singapore | SIN | 7 | 1,28 | 1,13 | 1,75 | 1,88 | 83,66 |
| Spain | SPN | 7 | 1,18 | 1,38 | 1,87 | 2,29 | 82,24 |
| Serbia | SRB | 6 | 1,23 | 1,06 | 2,06 | 1,87 | 74,51 |
| Sweden | SWD | 10 | 1,23 | 0,92 | 1,74 | 1,50 | 82,43 |
| Switzerland | SWZ | 10 | 1,12 | 1,21 | 1,79 | 1,70 | 83,06 |
| Thailand | THI | 4 | 1,28 | 1,07 | 2,82 | 2,06 | 77,33 |
| Tunisia | TUN | 5 | 1,22 | 1,04 | 2,11 | 1,74 | 75,00 |
| United Kingdom | UK-GBR | 9 | 1,21 | 1,14 | 1,74 | 1,51 | 80,39 |
| Ukraine | UKR | 6 | 1,16 | 1,24 | 2,92 | 2,35 | 73,28 |
| United States of America | USA | 9 | 1,21 | 1,29 | 1,95 | 1,57 | 77,01 |
| Uruguay | URU | 9 | 1,22 | 1,15 | 2,05 | 1,94 | 78,38 |
| Venezuela | VEN | 3 | 1,27 | 1,10 | 2,54 | 1,80 | 72,37 |
| Viet Nam | DRV | 4 | 1,46 | 1,30 | 2,87 | 2,14 | 75,38 |
| Zimbabwe | ZIM | 1 | 1,24 | 1,01 | 1,26 | 1,38 | 61,53 |

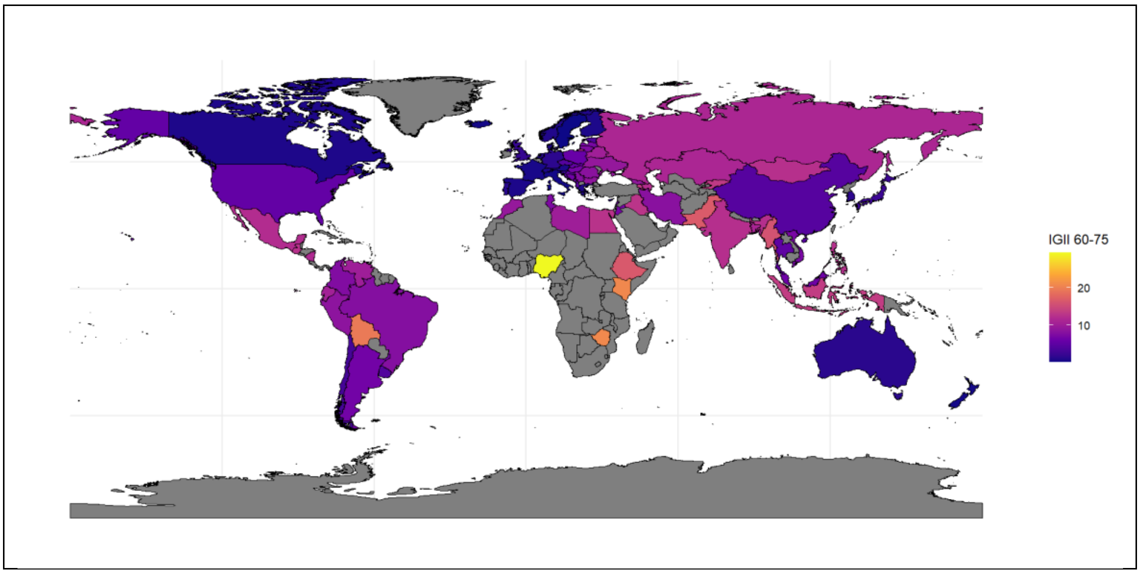
**Source**: Prepared by the authors, based on data from World Population Prospects (2024), World Values Survey (2017-2020, wave 7) and United Nations.

## Appendix 5– Indirect Gender Inequality Index for age groups






**Source**: Prepared by the authors, based on data from World Population Prospects (2024), World Values Survey (2017-2020, wave 7) and United Nations.