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The Models of Age-specific Mortality Rates and Their Patterns from Female Total Population Counts

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Abstract

If net migration is negligible, population change in a country is governed by an increase due to births and a decrease due to deaths. This study focuses on the mortality of female population based on their total fertility rates. It develops a simple method to analyze population data with the aim to estimate age-specific mortality models for 54 countries in the world and identify a similar pattern among them. Specifically, the method involves estimating the mortality rates of those countries with negligible net age-specific migration to form the common models. These models are then applied to other countries by matching mortality at older ages to verify similar patterns. The results show three different mortality models which imply the differences in the mortality patterns between the countries studied.

Keywords

Age-specific female mortality; mortality patterns; population data

Introduction

Mortality pattern refers to human survival and longevity in any population. It is a key indicator of health and development of the nation (Sharrow, Clark, & Raftery, 2014). Changes in the population structure of a country have been historically regulated by mortality (Schröder, Leeuwen, & Cameron, 2014). Therefore, reducing mortality has been a major goal of population health policies with considerable investments in public health and medical technology to extend longevity and improve public health (Bangha, 2013). It has been documented that declines in mortality compensate for decreased fertility rates, so mortality and fertility rates impact population growth considerably (Shelton, 2014). The declining trend is particularly evident in child and maternal mortality rates in the studied countries that have the appropriate records since the 1960s (Liu et al., 2015). Furthermore, female mortality remains high, mostly in Sub-Saharan Africa and Southeast Asia, because of poor health-related behaviors and socioeconomic status (Johri, Ridde, Heinmüller, & Haddad, 2014; World Health Organization, 2015a).

While human mortality affects everyone and differs by country because of the discrepancies in economic development, resulting from the industrial revolution and sanitary progress (Meslé & Vallin, 2010). Additionally, mortality patterns of the countries heavily depend on the mixture of other socioeconomic factors, such as incomes and educational levels. These

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differences in mortality rates are confirmed by a study which assesses social-economic factors among countries in Western Europe to reveal their effects on morbidity and mortality (Mackenbach et al., 1997). The differences in mortality are associated with inequalities in life expectancy at birth by country, ranging from low life expectancy in low-income countries to high life expectancy in high-income countries (World Health Organization, 2004).

Throughout the world, females have a longer life span and more life advantages than males (Chaudhuri, 2015; United Nations, 2015a). The difference in the longevity and mortality rates of females and males across the different countries is regulated by their biological, behavioral and environmental factors (Stevens, Mathers, & Beard, 2013; Pirkis et al., 2016). Globally, the total female population was 3.6 billion in 2015 (United Nations, 2015a), and more than half of them are living in poverty and with poor health and nutritional status (World Bank, 2012). In 2015, around 14,545 children and 822 mothers were dying daily due to the unavailability of health care services, poor nutrition, maternal and child health complication, violence, sexual abuse and other causes. More than 90% of them were from low- and middle-income countries (World Health Organization, 2015b; United Nations Children's Fund, 2016). In contrast, only 10% of those children and just only 1% of those mothers were dying daily due to the behavioral, environmental and maternal complications in high-income countries (World Health Organization, 2015a).

Females in general have negative health effects in their entire course of life due to lower access to maternal and child health care. Hence, gaining knowledge of female mortality can be beneficial in improving health policy, and thus improving the survival and extending the longevity of females. Additionally, to estimate female mortality rate in the easiest way for an international scale is difficult, because it requires a good record of registration system. Moreover, female mortality plays an important role in the demographic analysis, which helps to estimate and project the population size (Upadhyay et al., 2014). The results of the analysis can contribute to better handling of population growth and managing aging populations. One important characteristic of mortality is its age-specific rate (Brown, 2003).

Many researchers and international organizations have estimated the age-specific mortality rate using different models and techniques from censuses, vital registrations, data and household surveys (Clark & Sharrow, 2011; Wilmoth et al., 2012). Nevertheless, it has been found that most of the developing countries and even some developed countries were lacking complete vital registration data, and some demographic data required to calculate age-specific mortality (Luy, 2012; Adegboye & Danelle, 2014). To handle this issue, the census-based method from the stable population (Preston & Bennett, 1983), forward projection technique and modified growth balance equation have been used for estimating adult mortality (Preston, Coale, Trussell, & Weinstein, 1980; Bennett & Horiuchi, 1981). These studies imply that age-specific mortality rate can be determined using only population data from the census without death registrations. Even though the census-based method can be implemented for determining the mortality rate, more than half of all countries in the world do not have their own censuses with high quality acceptable data (Raftery, Chunn, Gerland, & Ševčíková, 2013; US Census Bureau, 2016).

Based on these observations, the estimation of common models for age-specific mortality rates for females across a group of countries can help develop understanding of the mortality patterns for each of the studied countries. However, it is not easy to gather information regarding complete vital registrations and censuses from each country. There have been two major projects on gathering population and mortality data. Human Mortality Database (2017) provides detailed information on age-specific deaths and mortality rates among other population-related data. However, data for age-specific mortality rates from these data sets are only available for 39 countries and most of them are high-income countries. The other project is International Data Base from U.S. Census Bureau (US Census Bureau, 2016). Even though the population data from this project are based on a projection, not a census, the project provides accurate and reliable population data including fertility rates and mortality indicators by gender for most countries around the world. Therefore, data from International Data Base is useful for studying a large group of countries. Despite the usefulness of other population data in this project, the information on age-specific mortality is still lacking. Therefore, this study is intended to develop models for female age-specific mortality for selected countries around the world using a simple and straightforward technique using data from the US Census Bureau.

Methods

The study used data on female population in 54 countries, from 1990 to 2015, retrieved from the US Census Bureau (2016). Only the world's most populous countries were selected here, and these 54 countries were chosen to equally represent Africa, Asia, and Western countries, with 18 countries for each region. These regions were grouped based on birth, death, and migration patterns. For example, Sub-Sharan countries showed similar patterns of birth and death rates (Tabutin, Schoumaker, & Rabenoro, 2004) while South Asia tended to have different patterns (Véron, Horko, Kneipp, & Rogers, 2008).

Previously, Coale, and Demeny (1966) used age-specific population data to develop their classical model life tables for 192 countries, which were basically grouped according to geographical regions. The countries within one geographical region usually shared the same life table model. Nevertheless, there could be exceptions where a country from another region is included in the life table model based on its region: for example, Taiwan and Japan are in the West model (Coale & Demeny, 1966). Therefore, the concept of grouping population trends based on their regions and similarities was adopted in this study. This study was aimed at estimating the models for the mortality rates of each group of countries. However, the mortality rates were not calculated directly, but rather extracted from the population change. For this study, the population change was a combination of mainly mortality and migration. First, population change was calculated using a simple method based on the population data of a single calendar year and age of the females. In order to estimate the age-specific population change for a female population, the following equation was used:

$$\text{Population change} = 1 - \frac{N(x+1, t+1)}{N(x, t)}$$

Where, the function N(x, t) is the number of persons aged x in year t and N(x+1, t+1) is the number of persons age x+1 in year t+1.

Subsequently, the estimated mortality rates for each country were calculated by minimizing the values for all years. It was found that including data from all years from 1990 to 2015 gave the results that required smoothing, and the better results were obtained by selecting fewer years. Therefore, only data for 1991, 1992, 1995, 1996, 2000, 2001, 2005, 2006 and 2008-2015 was consequently selected. The calculated mortality rates were then plotted using a cubic root scale to ensure the variance homogeneity assumption plausible. Single ages from 0 to 85 years were used and the mortality rate for all countries were grouped by patterns, based on the level of fluctuations in the plots. In order to create a baseline, countries with the least fluctuating patterns were selected and then divided into sub-groups based on similarity of mortality patterns.

For countries with only slightly deviating patterns, it was reasonable to assume that migration was negligible. Net migration rates per 100,000 population and life expectance in year 2010-2015 in each country are shown in Table 1 (United Nation, 2017). In each sub-group, taking the median of population change provided a filtering mechanism to diminish migration, and it therefore represented the baseline for population change in the sub-group. This baseline is considered the model of mortality rate for each sub-group because of the removal of migration from population change. These medians or the model of mortality rates were then used in relation to population change from other levels of fluctuation to form sub-groups in each level. A country with population change at old ages matching the pattern of any particular model of mortality rate was then added into a corresponding sub-group as it was reasonable to assume that migration at older ages was negligible. In each sub-group, the difference between the population change and the model of mortality rate indicated migration, either immigration or emigration for each age level. When the population change for all 54 countries were categorized into groups according to the medians or the mortality rates, it could be observed that the patterns of mortality rates could systematically identify the model of mortality rates for each group. Countries with positive population changes and the fluctuation of population change between current age group and next age group approximate 0-200 per 100,000 female population are placed in smooth pattern. Countries with negative population change and the fluctuation of population change between 200-500 per 100,000 female population were classified into mild fluctuate pattern while countries with negative population change and the fluctuation of population change more than 500 per 100,000 female population were classified into highly fluctuated pattern.

Table 1: Net migration rate and life expectancy for each country

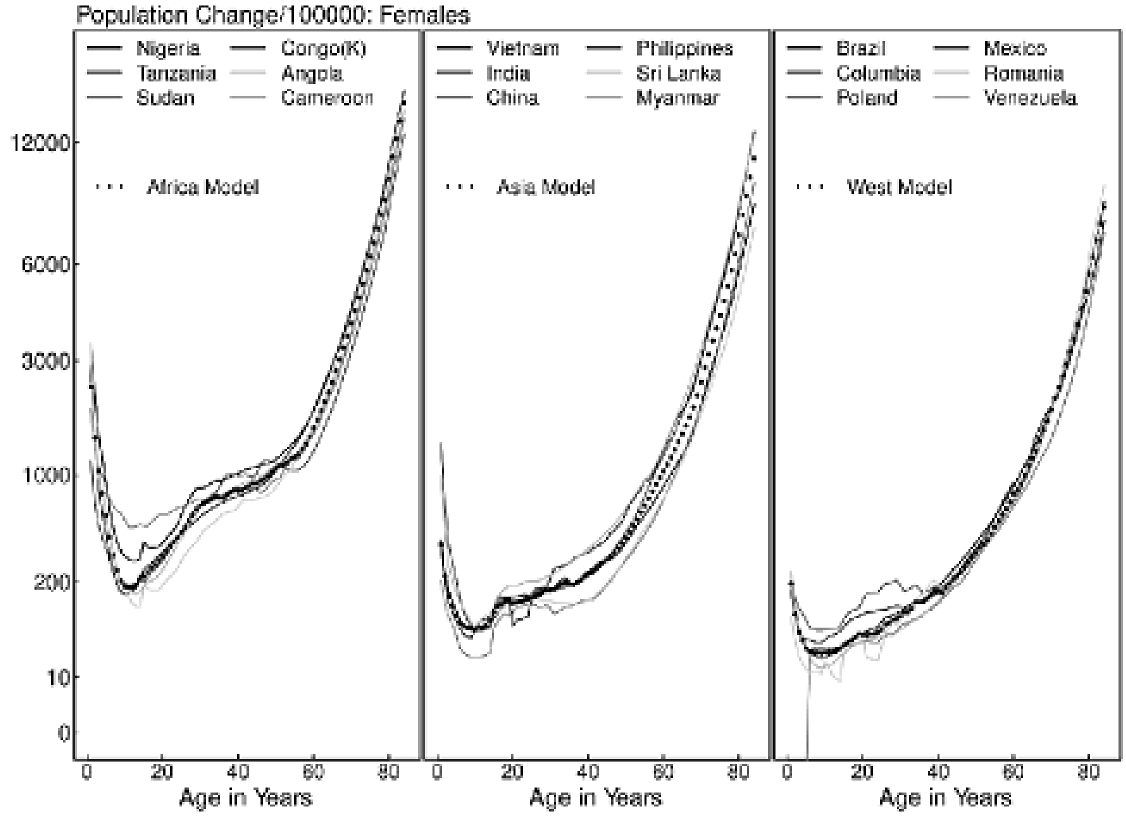
Countries	Migration	Net migration rate (per 1,000)						Life expectancy rate
		1990-1995	1995-2000	2000-2005	2005-2010	2010-2015	Average	
Smooth pattern								
Nigeria	Low	-0.2	-0.2	-0.3	-0.4	-0.4	-0.3	51.9
Sudan	Moderate	5.9	-4.9	-3.8	-6.6	-3.2	-2.5	63.6
Congo	Moderate	1.7	3.3	2.9	4.7	-2.6	2.0	62.6
Tanzania	Low	4.3	-1.3	-1.6	-1.2	-0.8	-0.1	69.8
Angola	Low	2.2	-1.7	1.9	0.8	0.7	0.8	60.2
Cameroon	Low	-0.8	-0.7	-0.7	-0.6	-0.3	-0.6	56.4
Viet Nam	Low	-1.1	-0.6	-1.6	-2.0	-0.4	-1.1	75.6
China	Low	-0.1	-0.1	-0.3	-0.4	-0.3	-0.2	75.7
India	Low	-0.1	-0.1	-0.4	-0.5	-0.4	-0.3	82.2
Philippines	Moderate	-1.5	-2.1	-2.7	-3.3	-1.3	-2.2	68.6
Sri Lanka	High	-2.9	-5.0	-4.7	-5.2	-4.7	-4.5	82.5
Myanmar	Moderate	-3.3	-2.4	-5.3	-6.0	-1.9	-3.8	66.0
Brazil	Low	0.0	0.0	0.0	0.0	0.0	0.0	74.7
Colombia	Low	-1.3	-1.0	-0.8	-0.6	-0.6	-0.9	73.8
Poland	Low	-0.8	-0.4	-1.0	-0.9	-0.4	-0.7	77.0
Mexico	Moderate	-2.9	-4.8	-5.5	-0.4	-0.5	-2.8	76.5
Romania	High	-4.5	-5.4	-4.3	-7.4	-3.0	-4.9	74.9
Venezuela	Low	0.0	0.0	-0.1	-0.2	-0.5	-0.2	71.4
Mild fluctuating pattern								
Uganda	Low	1.3	-0.4	0.0	-0.9	-0.8	-0.2	58.6
Burkina Faso	Moderate	-3.2	-2.5	-2.0	-1.7	-1.5	-2.2	58.7

Countries	Migration	Net migration rate (per 1,000)						Life expectancy rate
		1990-1995	1995-2000	2000-2005	2005-2010	2010-2015	Average	
Ivory coast		-	-	-	-	-		82.4
Nepal	High	0.8	-4.1	-6.5	-7.8	-2.7	-4.1	61.8
Peru	Moderate	-2.6	-4.3	-4.8	-3.4	-1.6	-3.3	74.2
Ghana	Low	-0.2	-1.3	1.6	1.6	-0.4	0.3	61.7
Iran	Low	-7.2	1.9	-0.2	-1.5	-1.0	-1.6	68.6
Uzbekistan	Low	-3.0	-2.0	-1.9	-1.0	-0.5	-1.7	77.0
Indonesia	Low	-0.4	-0.3	-0.8	-0.6	-0.7	-0.6	68.6
North Korea	Low	0.0	-0.1	-0.2	-0.2	-0.2	-0.1	51.9
Algeria	Moderate	-0.9	-1.1	-1.3	-2.1	-0.8	-1.2	75.3
Thailand	Low	-2.1	2.3	1.2	0.2	0.5	0.4	74.6
Egypt	Low	-1.5	-0.6	-0.2	-0.7	-0.6	-0.7	70.8
Russian	Moderate	3.4	3.1	2.4	3.0	1.4	2.7	74.9
UK	Moderate	0.7	1.7	3.3	6.6	3.1	3.1	81.0
Germany	Moderate	6.6	1.7	2.0	0.1	4.4	3.0	80.5
Argentina	Low	0.2	-0.4	-0.5	-0.4	0.1	-0.2	76.0
France	Low	1.1	1.3	1.6	1.7	1.1	1.4	81.9
Highly fluctuating pattern								
Madagascar	Low	-0.2	-0.1	-0.1	-0.1	-0.1	-0.1	64.5
Ethiopia	Low	5.6	-0.5	-0.2	-0.1	-0.1	0.9	63.7
South Africa	Moderate	3.7	1.4	2.5	2.5	3.0	2.6	59.5
Mozambique	Low	9.0	-0.6	0.3	-0.4	-0.2	1.6	56.1
Kenya	Low	1.8	-0.2	0.2	-1.0	-0.2	0.1	65.4
Pakistan	Moderate	-1.7	-1.1	-0.9	-1.7	-1.3	-1.3	76.2
Morocco	Moderate	-3.6	-4.0	-4.4	-3.6	-1.8	-3.5	74.9
Bangladesh	Moderate	-1.4	-1.2	-2.2	-4.8	-3.2	-2.6	76.4
Malaysia	High	3.1	4.5	5.3	5.3	5.3	4.7	74.7
South Korea	Low	0.3	0.7	0.3	-0.6	0.7	0.3	59.5
Turkey	Low	-0.4	-0.3	-0.1	-0.1	4.3	0.7	74.8
Japan	Low	0.1	-0.2	0.3	0.4	0.6	0.2	83.3
Taiwan	Low	-1.3	-2.6	1.9	2.2	1.5	0.3	69.8
USA	Moderate	3.5	6.3	3.6	3.3	2.9	3.9	62.8
Spain	High	1.6	4.5	13.4	10.0	-2.5	5.4	82.5
Australia	High	4.0	4.1	5.9	10.6	8.0	6.5	82.3
Canada	High	4.9	5.1	6.5	7.4	6.5	6.1	56.4
Italy	Moderate	0.5	0.8	5.6	3.4	0.9	2.2	82.4

Findings

After calculating the mortality rate from population change for 54 countries and plotting the graphs reflecting population change, it was found the population change pattern could be categorized into three groups based on migration: smooth, the mild fluctuating and the highly fluctuating patterns. The smooth pattern group describes the smoothest pattern of female mortality rates with sharing the low net migration countries, while the other two groups showed mild and high fluctuating with intermediate and high net migration. Thus, the name of each pattern was assigned by the fluctuations in plots for each group.

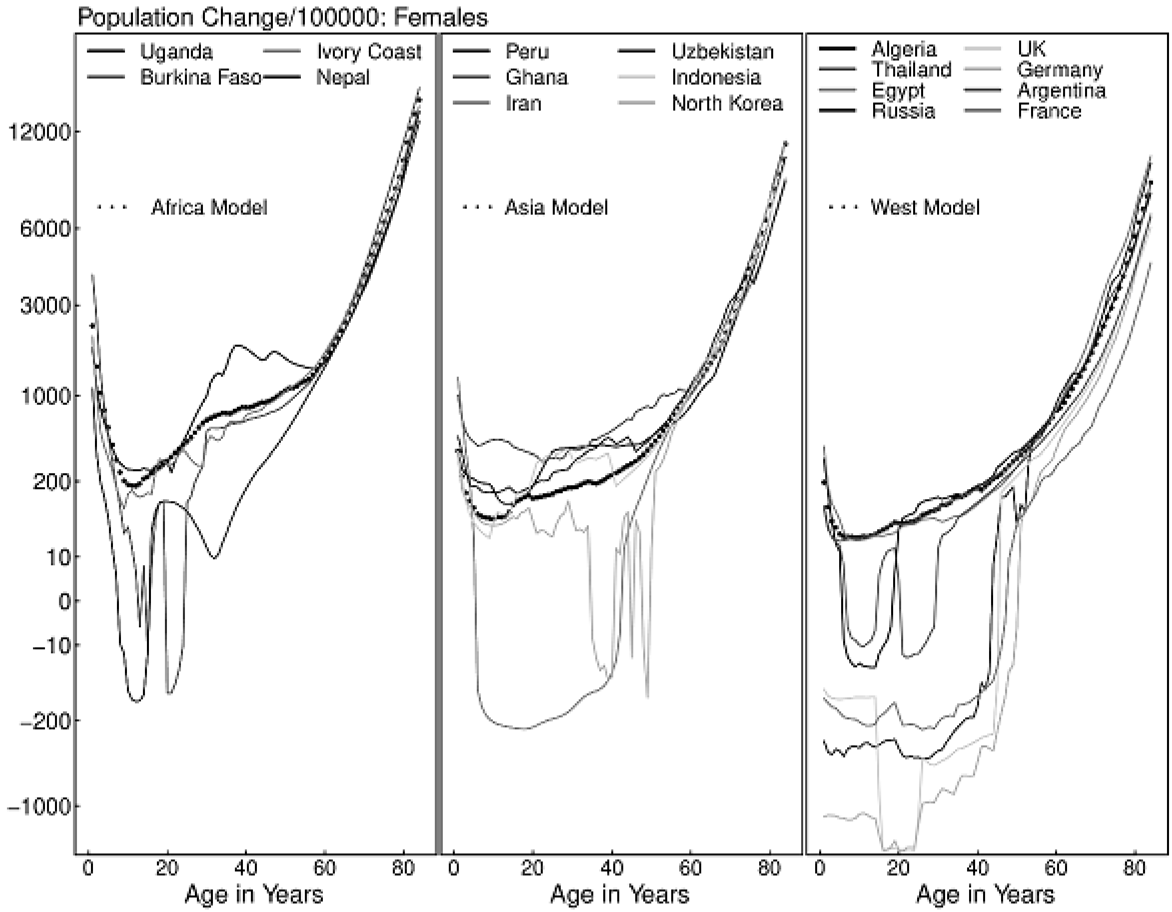
Figure 1: Good patterns of population change



For the smooth pattern, the countries in this group were further divided into three sub-groups based on the patterns in the population change plots. Figure 1 shows the smooth pattern of population change of females for ages 0 to 85 years for all three sub-groups, with the population change shown using a logarithmic scale. The ages below 1 year, 1 to 15 years, 16-59 years and over 59 years were defined as an infant, adolescence or young age, productive age and old age respectively. The first sub-group on the left panel of Figure 1 reveals the population change for six African countries, including Angola, Cameroon, Congo (K), Nigeria, Sudan and Tanzania. In this sub-group, all the countries have similar pattern of population change in infant and old age categories. However, in the productive age, the population change shows wider dispersion among these countries. The graph in the middle panel of Figure 1 shows Myanmar, China, India, the Philippines, Sri Lanka and Vietnam. In this plot, the variation of population change in these six Asian countries mostly is in the adolescence, productive and old ages. However, in the adolescence and productive ages, the population change shows fluctuations among these countries. The right panel of Figure 1 shows Brazil, Columbia, Mexico, Poland, Romania and Venezuela, with the least change in population at young and old ages. In this sub-group, Poland showed a highly negative population change at around 10 years of ages.

The median of each sub-group was created and these medians were considered the models of mortality rates: Africa model, Asia model and West model according to the common location of the countries in each sub-group. The models of mortality rates for all three sub-groups are shown in Figure 1 as dotted lines. The shape of the model in each group indicates the common pattern of mortality rate for the countries of that group. In the Africa model, the model started at a high level before dropping significantly from infant to the age of 10 years. It then started to go up sharply until age 35 after which the slope was less steep. The slope changed again at age 60 when the population change went up more rapidly again. In the Asia model, the model of mortality rate started at a lower level than in the previous model and dropped with a hook shape from infant to 20 years of age. The rate then had a gentle slope with small oscillation from 20 to 40 years and it went up exponentially afterwards. The model began as lowest among the three models before dipping until age 10. After that, it moved up with an exponential rate towards the end. Additionally, there was little fluctuation between ages 20 and 50 in this model.

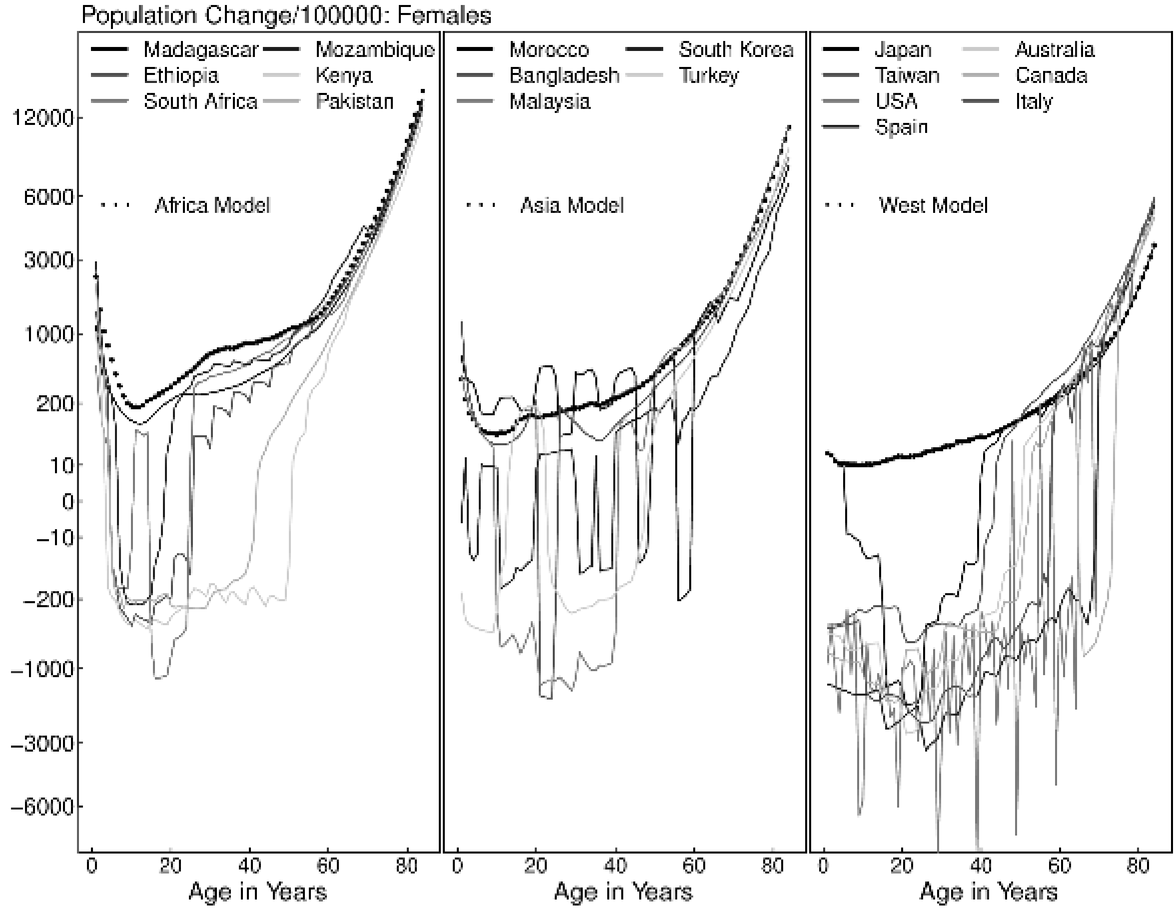
Figure 2: Wobbly patterns of population change



The mild fluctuating patterns in Figure 2 represent 18 countries. The three models of mortality rate (Africa, Asia and West models), from the smooth patterns, were used to categorize these countries by matching them with the models by considering similar patterns at old ages. The results showed that all of the 18 countries can be categorized by the three models, thus forming three sub-groups. The left panel of Figure 2 represents the Africa model assigned to the four countries, Burkina Faso, Ivory Coast, Nepal and Uganda. All these countries had almost similar patterns of population change at the infant and old age, while in the productive age of females the population change had moderately fluctuating patterns. The middle panel shows the Asia model matches Ghana, Indonesia, Iran, North Korea, Peru and Uzbekistan. In this sub-group, the estimated female population change rates are often unsymmetrical, mostly in young and productive ages, but in the old age group, the countries showed quite similar patterns. Only Iran and North Korea had a negative change in population, mainly around ages 15 to 40 and from 40 to 60 respectively. The right panel of figure 2 consists of eight countries matching West model at old ages, namely Algeria, Argentina, Egypt, France, Germany, Russia, United Kingdom and Thailand.

In this sub-group, all the countries had a negative population change except for Egypt and Thailand.

Figure 3: Bad patterns of population change



The highly fluctuating pattern cases shown in Figure 3 are also reflected in 18 countries, with severe and erratic fluctuations patterns of population change. Similar to the previous process, these countries were classified into sub-groups by matching with the three models. In the left panel of Figure 3, the six countries, Ethiopia, Kenya, Madagascar, Mozambique, Pakistan and South Africa, are in the same group matching the Africa model while the Asia model is matched with five countries, namely Bangladesh, Malaysia, South Korea, Turkey and Morocco. In the right panel of Figure 3, the West model is matched with seven countries: Australia, Canada, Italy, Japan, Spain, Taiwan and the US. All these countries in the latter group showed erratic fluctuations of population change with negative deviations.

Discussions

The present study provided estimates of the models of female mortality based on the latest population data by calculating a population change. The population change of these 54 world's most populous countries were divided into three categories: African model, Asian model and Western model. It was shown based on their patterns, all the 54 countries could be systematically classified into groups based on medians or the models. The patterns in the models could be considered estimates of the mortality rate. Even across different countries, humans share virtually similar patterns of mortality rates, higher at infant and at old age while lower during adolescence and productive ages, in a normal situation (absence of wars or natural catastrophes). The major differences in population change between countries are mostly due to human movements or migration, and due special circumstances such as outbreak of a disease. The use of medians as common models for mortality rates was confirmed by the findings that indicated consistent results. It was shown that the countries sharing the same characteristics as the model shared characteristics which distinguished them from countries assigned to other models. In the Africa model, a higher mortality rate was found among infants, adults and older females compared with Asian and Western models. In the Asian model, the estimated mortality rate was clearly lower than in the Africa model, but higher than in the Western one. These findings are consistent with Hill, You, Inoue, and Oestergaard (2012), where Africa showed higher rates of the death for children, while Asia/Pacific and Western countries had the lowest. In Africa, 1 out of 12 children dies before reaching their fifth birthday, while it is 1 death among 19 children in Southeast Asia. In developed countries, itis 1 out of 147 children, a considerably lower mortality rate (United Nations Children's Fund, 2015). Other studies have found that countries in Africa and Southeast Asia have the highest mortality rates for adult and old-aged females due to high prevalence of HIV/AIDS, poverty, malnutrition, maternal complications, violence against women, and power and decision-making in African and Asian countries (United Nations Programme on HIV/AIDS, 2013; United Nations, 2015a). In contrast, the mortality levels among females in western countries have been declining for all ages. This is due to considerable improvements in public health policies and rapid economic development. The same situation with respect to female mortality has been well documented in other studies, where it is evident that females face a far worse situation than their male counterparts. Hence, in the low and middle-income countries, females are at an elevated risk of dying in their entire lives (Hill et al., 2007; Sawyer, 2012; Stevens, Mathers, & Beard, 2013 Alkema et al., 2016). A joint study by the World Health Organization, (2015b), and United Nations Children's Fund, (2015) revealed that females are dying due to lack of basic health care, poor and inadequate education, poor nutrition and violence in the developing countries of Sub-Saharan Africa and Southeast Asia, while another study also reported high female mortality rates for the same regions. Therefore, it can be inferred that the mortality rate is dependent on the country's level of socio-economic and cultural development (Liang et al., 2010; Bayati et al., 2016).

This study developed a model of female mortality rates based on patterns in the populations of several countries. The patterns were classified into three categories: smooth, mild fluctuating and highly fluctuating. The smooth patterns had fine patterns of population structure, while the mild fluctuating patterns showed some deviations of patterns of population change among the productive age females, and the highly fluctuating patterns had severe fluctuations patterns throughout the ages from 0 to 65. These patterns also helped in estimating mortalities, as explained earlier. If the population change is positive, it is reasonable to assume that the net age-specific migration is negligible. In such a case, the pattern of population change in the females directly reflects the estimated mortality rate. This is because infants and older people do not migrate due to inherent bias and other specific issues such as physical challenges and policies (Angel, 2003; World Health Organization, 2016). Therefore, the changing population figures in these age groups are not affected by migration but rather by death rate.

In the smooth pattern, all of the countries had a positive fluctuation pattern in the population change, so it is reasonable to assume that migration is negligible. Therefore, these countries provide the most reliable estimates of female population changes, interpreted as mortality. In the mild fluctuating and the highly fluctuating patterns, most countries had irregular negative fluctuation patterns of the population change. If the population change is negative, this reflects immigration. This mostly happens at younger ages for females in high and some middle-income countries due to net positive migration into these countries. Therefore, UK, USA, Canada, Australia, Germany, France, Italy, Russia, Spain, Turkey, Taiwan, Algeria, Kenya, South Africa, Bangladesh, Iran, Malaysia, Pakistan and South Korea can be considered hosts for immigrants of productive age from other countries. This finding is consistent with prior literature. A United Nations report (2015b) showed that more than 48% of females migrated to western countries, and some immigrants went to African and Asian countries. This is because these countries have smooth income, high literacy levels and good medical facilities. Therefore, these countries have hosted a large number of immigrants, both legal and illegal ones, and refugees (United Nations, 2015a). In contrast, this type of migration stops at old ages among the female population. Angel (2003) explained that this scenario is due to the fact that at higher ages, the immigrants face greater distress having little savings and inadequate health insurance coverage.

In low and most middle-income countries, fluctuations of pattern were found to be at low level. It is again reasonable to assume these countries have negligible immigration. If the immigration is negligible, then it is reasonable to accept the population change depends on mortality rate and possibly emigration in some cases. Despite this, Morocco showed an exact opposite fluctuation pattern with a repeatedly bumping pattern of population change at productive age. This could be due to combined emigration and mortality. This is confirmed by previous studies that during the period 1990-2015, a large number of emigrants from Morocco fled to other countries as refugees or migrant labor and transiting to different destinations. In addition, around 18.43 per 100 female adults also died due to maternal and child health complications, and other reasons in Morocco (United Nations Economic Commission for Africa, 2016; World Data Atlas, 2016).

Conclusion

This study showed female mortality patterns in 54 most populous different countries in the world. This result, in combination with fertility data, is beneficial for exploring female population dynamics for these countries. Furthermore, the countries in each model shared the same pattern of mortality rate, and there could be a similar demographic pattern among countries in the same region. Therefore, it is an indication the countries might also share a common socioeconomic, health or development situations which can be explored in future studies. With the exception of Japan and Taiwan in West model, it could be implied these two countries possess similar socioeconomic, health or development situations with other countries in their respective mortality pattern model.

Although the method used in this study was aimed at providing estimates of female mortality rates for developing and developed countries based on their population change, it is more suitable for the least developed and developing countries where migration is relatively low. In high income countries, where immigration is fairly high except for old age, this approach is not suitable to study population change among the young and the productive female population. Another restriction of this study is that the accuracy of the estimates can be disputed because they relied mainly on the accuracy of the source data. While the US Census Bureau has provided a great deal of reliable projected population data, there are many factors and turning points that could affect population projections, and in turn, the estimated population change and mortality rates. Further studies including a large sample size of countries might help capture model patterns and increase the understanding of characteristic of population change and mortality rates.

In summary, in this study, age-specific mortality rates were estimated from the population data by using a simple population change method. This method can be employed to reveal the mortality rate if the countries experience low net migration. For the high migration countries, the effects of migration must be filtered out by using the median or model for more reliable cases before estimation of the mortality rates. The study found higher female mortalities in African countries rather than in Asian and Western countries across all age groups of the female population.

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