Trends, projections, and regional disparities of mortality in Algeria (2018 – 2070): Exploring survey data

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Background

Mortality estimates and forecasts are much needed in policymaking and actuarial calculations. National mortality estimates and projections are usually based on heterogeneous sub-populations. Thus, using national estimates for purposes related to a subpopulation may distort all calculations. Studying the regional inequalities in mortality may help better assess the effectiveness of public health policies at a regional level and better predict the differences in terms of longevity and mortality evolution between regions within the same county.

The aim of this paper is to estimate and forecast complete sex and age-specific mortality rates from age 0 to 120 years old in seven sanitary regions in Algeria from 2018 to 2070. This process of estimation and forecasting requires the availability of data at the regional scale, which is often characterised by sparsity, noise, and a lack of long-time data series.

To address these challenges, this paper investigates the Multiple Indicator Cluster Surveys database to measure and forecast regional age-specific mortality rates in Algeria for 2018-2070. The raw mortality rates estimated using MICS surveys need to be adjusted to ensure smoothness and completeness of mortality curves by proposing a standardised mortality approach that could be applied in the context of defective mortality information. Many researchers applied the indirect standardisation method to estimate mortality rates for small areas (Curtin & Klein, 1995; Ram et al., 2015; ABS, 2016; NRS, 2016; Kim et al.,2020).

Data and methods

Algerian mortality data

This paper uses data from the latest wave of Multiple Indicator Cluster Surveys for Algeria carried out in 2018-2019 (MICS VI). The MICS surveys use a stratified two-stage cluster sampling design and cover a random sample of 31,325 households distributed according to the seven territorial programming regions in Algeria. The considered regions are: north central region, northeast region, northwest region, central highlands, eastern highlands, western highlands, and great south.

The dataset allows for extracting regional information about death count records and person-years of exposure to the death risk by sex and age. These initial data will be adjusted to ensure the smoothness and completeness of regional mortality rates. To this end, we use national age-specific mortality data published by the National Office of Statistics (ONS[1]) as a standard. These data are averaged for the period 2018–2019 to ensure consistency with regional mortality rates estimated from MICS surveys.

The same data source is used for projecting regional mortality rates from 2020 to 2070. First, we use historical national civil registration-based life tables for the period 1977 – 2019 from the ONS to forecast the national mortality surface. Second, regional projections are produced in accordance with the national forecasts.

Indirect standardisation and forecasting framework

The indirect standardisation method requires the calculation of the SMR (Standardised Mortality Ratio). This measure represents the ratio of the observed number of deaths in a specific region to the expected number calculated on the basis of standard mortality rates (Lidell, 1984). It indicates a mortality excess in the regional population when the ratio is greater than one, and vice versa.

If there are k different mortality rates for k groups of a study population, defined by age, the SMR can be written as (Keiding, 1987):

$$SMR = \frac{\sum_{i=1}^{k} n_i \lambda_i^s}{\sum_{i=1}^{k} n_i \lambda_i^r}$$

Were, n_i represents the number of persons in the i-th age group of the study population, λ_i^s and λ_i^r are the mortality rates of the i-th group of the study and reference populations, respectively.

Regional mortality rates are projected by scaling forecasts of national mortality rates. The regional-to-national standardised mortality ratios by sex and region are utilised for projecting the regional mortality surface based on national projections, assuming that these ratios remain constant after the period 2018–2019. In our case, the projection framework follows four steps:

1. Collecting official estimates of sex-specific death probabilities from the national life tables published by the ONS for the period 1977 – 2019. The rates are published with abridged format Q_x.
2. Interpolating Q_x using the Q2q package under R (Flici, 2020) to obtain death probabilities by single age q_x. The death probabilities are transformed to mortality rates m_x using Fergany's approximation (Fergany, 1971):

[1] Alternative name in frensh: Office National des Statistiques.

$$m_x = -\log(1 - q_x)$$

3. Forecasting age and sex-specific mortality rates for the period 2020 – 2070 following the same methodology used by Flici (2021). The forecasts are performed using the product ratio method (Hyndman et al., 2013) for a historical mortality surface that covers the period 1997 – 2019 by single ages from 0 to 79. The mortality surface is extrapolated using Coherent kannisto method (Sevcikova et al., 2016).
4. Forecasting regional mortality rates by scaling national forecasts using the SMRs.

Results

The figures below represent the log of the regional mortality rates by sex for the ages between 0 and 84. The indirect standardised method provides smoothed rates, with few data requirements, and ease of implementation.

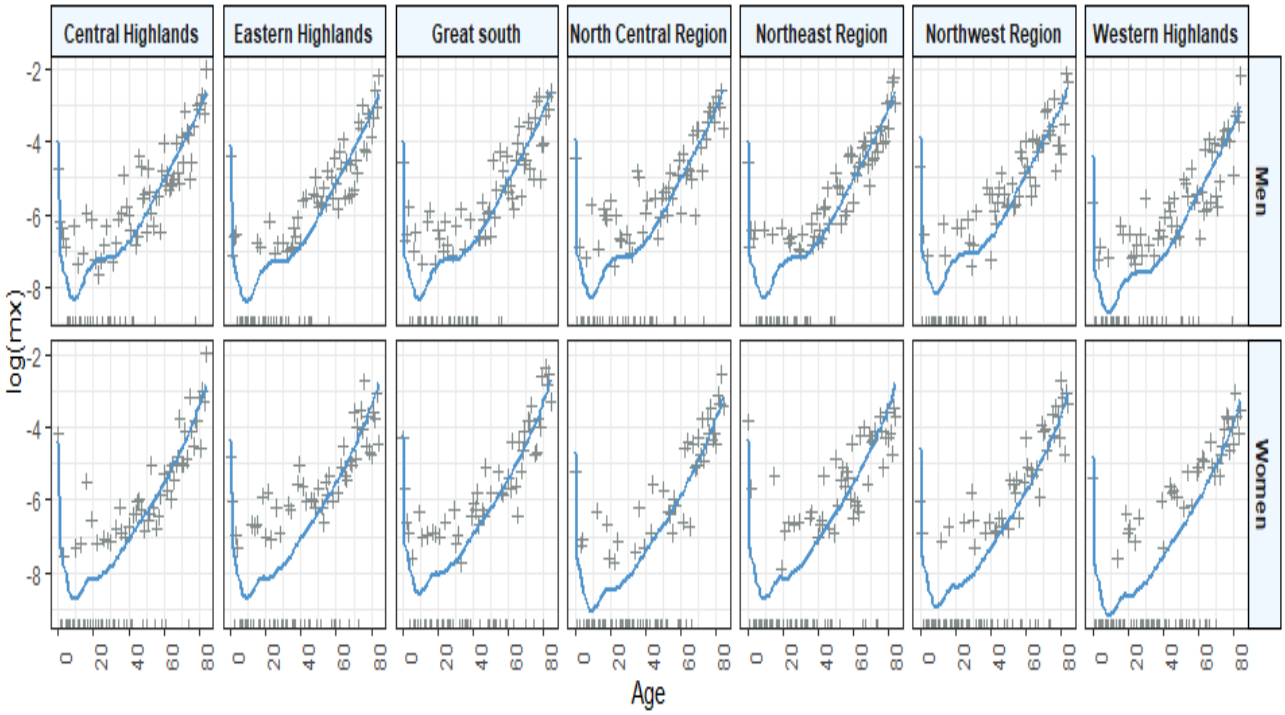

Figure.1: Observed and smoothed regional age-specific mortality rates by region for men using MICS VI data, the data covers the period 2018-2019. The grey points in the graph represent the observed mortality rates and the blue line represents smoothed mortality rates.

Regional mortality rates are projected following the methodology described before for single ages 0 to 120 considering the period 2020-2070 as forecast horizon.

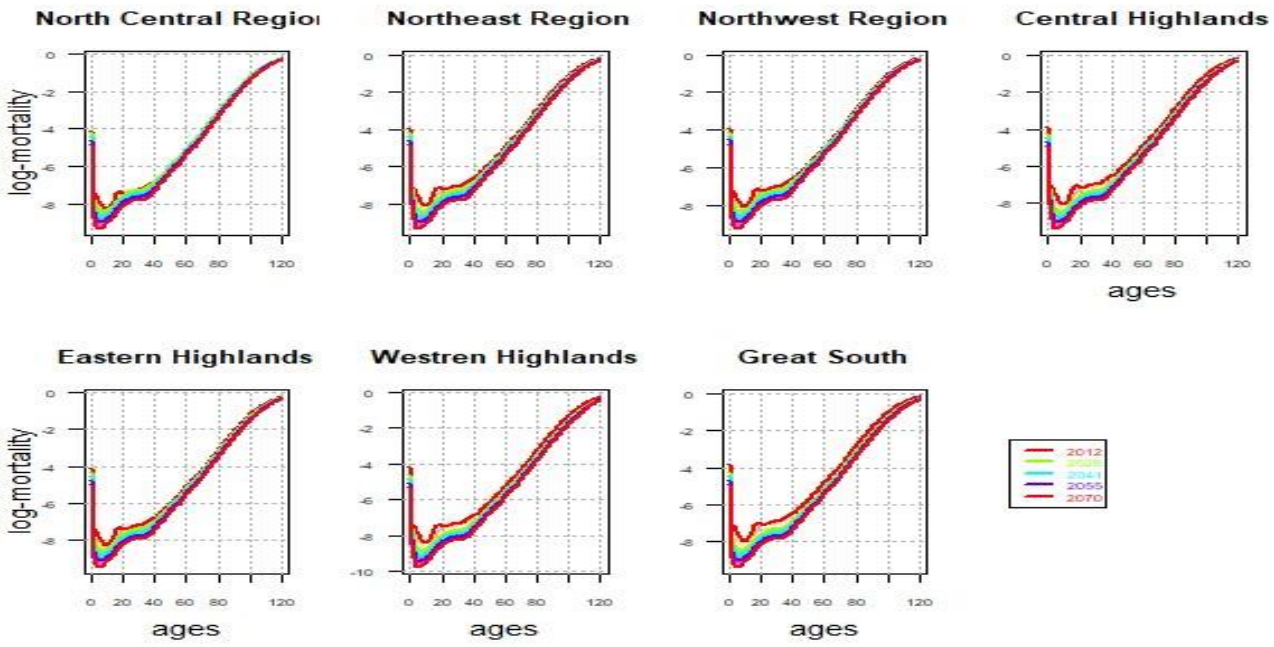

Figure.2: Complete mortality surface 2018 – 2070 for men

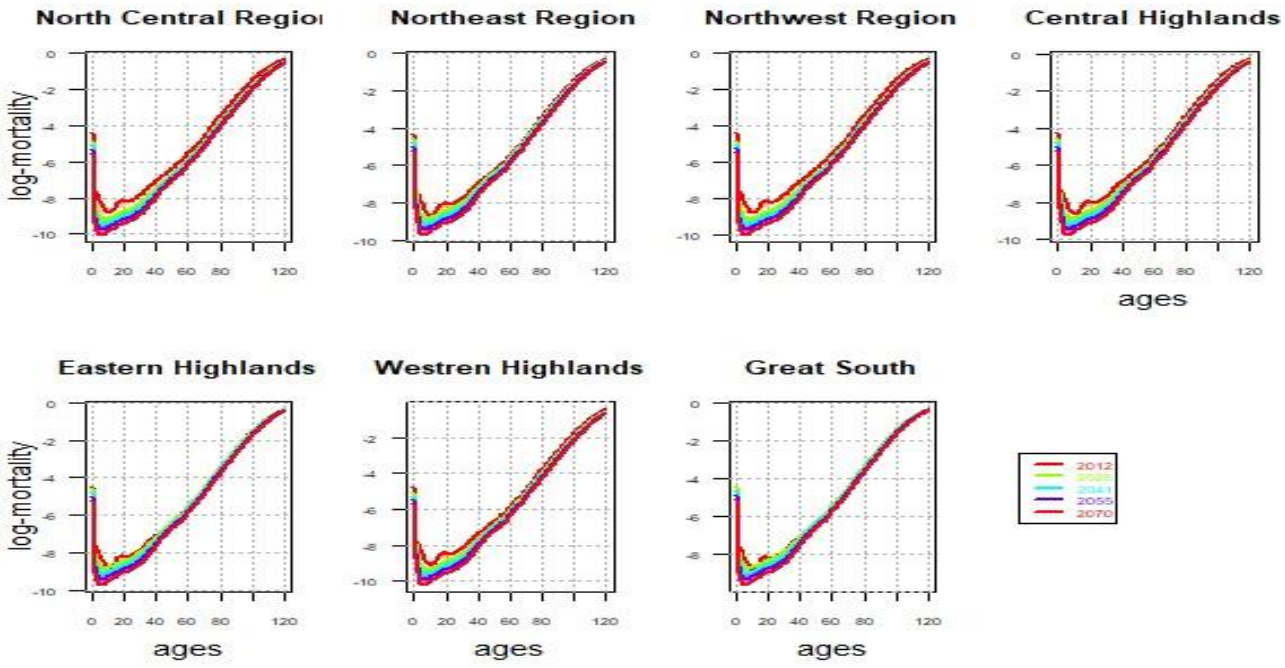

Figure.3: Complete mortality surface 2018 – 2070 for women

Comparing the estimates and forecasts of mortality rates by sex and region indicates the existence of mortality inequalities in favour of women, who recorded the lowest mortality rates over the period 2018-2070. The concentration of high mortality rates was observed in the northwest region and the great south region for men and women, respectively. However, the western highlands reported the lowest mortality levels for both men and women.