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Spatial modelling of under five child mortality and associated factors in Zimbabwe using 2011 and 2015 demographic and health survey data

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2021
https://hdl.handle.net/10539/33614

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ABSTRACT

Background

Under-five mortality (U5M) is a global public health concern as it is a measure of a country's overall performance. Zimbabwe failed to achieve millennium development goal 4 (MGD) to reduce U5M by two thirds in 2015 and as we target to achieve sustainable development goal 3 (SDG) which aims to reduce U5M to 25 deaths in 1000 live births in 2030, there is need to review the progress during the last two surveys (2011 and 2015) of the MDG period and identify risk factors of U5M. Children from the same geographical region are affected by similar factors, some of which are unmeasured and accounting for these factors through the incorporation of spatial effects produces more informative results. Therefore, the aim of this study was to determine and compare the spatial distribution of U5M while adjusting for possible risk factors in Zimbabwe at the district level between the two surveys.

Methods

The current study was based on secondary data analysis of data collected in the 2011 and 2015 Zimbabwe demographic and health surveys (ZDHS). The study population consisted of under-five children aged 0-59 months (both alive and dead). To describe the data, we used frequencies and percentages for categorical variables while means and standard deviations were used for continuous data. Univariate analysis of survival experiences for categorical variables was visualised using non-parametric Kaplan-Meier (KM) plots. Bayesian spatial survival models based on Markov chain Monte Carlo (MCMC) simulation techniques were fit to determine the spatial distribution of U5M at the district level for both surveys. Cox proportional hazards (Cox-PH) and accelerated failure time (AFT) models were the survival analysis models that were fit and they were adjusted for spatial frailty and possible risk factors of U5M. These models were run in OpenBugs and R statistical software and the best fit model was selected based on the lowest deviance information criterion (DIC) value. For visualisation of spatial heterogeneity of U5M at the district level, maps were plotted in both software for the two surveys.

Results

A total of 5,563 participants were considered in the 2011 survey and 6132 in the 2015 survey. After accounting for sampling weights, we found that 6.93% and 5.65% of the children died before five years in the 2011 and 2015 surveys respectively. Findings indicate that the U5M rates were significantly lower in 2015 compared to 2011. Relative to their respective reference categories which were singleton birth, being a boy child, average size at birth, being married, mother's non-use of contraceptives and Apostolic religion, the following results were obtained for U5M factors from the Cox-PH models. Multiple births (posterior HR (PHR) = 3.84; 95% CI: 2.56 - 5.50), being a girl child (PHR = 0.74; 95% CI: 0.60 - 0.90), the small size of child at birth (PHR = 1.73; 95% CI: 1.26 - 2.25), mother's single marital status (PHR = 0.32; 95% CI: 0.083 - 0.74), mother's contraceptive use (PHR = 0.53; 95% CI: 0.42 - 0.66), Pentecostal religion (PHR = 0.72; 95% CI: 0.51 - 0.94) and rural residence (PHR = 0.70; 95% CI: 0.48 - 1.00) were significantly associated with U5M in the 2011 survey. In 2015, multiple births (PHR = 4.52; 95% CI: 3.11 - 6.28), being a girl child (PHR = 0.79; 95% CI: 0.63 - 0.96), the small

size of child at birth (PHR = 1.81; 95% CI: 1.32 - 2.37), the large size of child at birth (PHR = 1.47; 95% CI: 1.15 - 1.85), mother's single marital status (PHR = 0.55; 95% CI: 0.24-0.99) , mother's contraceptive use (PHR = 0.51; 95% CI: 0.41 - 0.64), Pentecostal religion (PHR = 0.46; 95% CI: 0.24- 0.78) and other religions (PHR = 0.61; 95% CI: 0.42-0.84)

were significantly associated with U5M. Maps for exceedance probabilities suggested spatial clustering of U5M hotspots. Regions with higher chances of U5M hazards and low survival times were clustered in the northern, middle and eastern parts of Zimbabwe, while regions with lower chances of hazards were clustered towards the southern and western parts of Zimbabwe for both survey points.

Conclusion

Information on the geographical distribution of U5M across the country is important in understanding how frailty due to unmeasured effects at the district level can affect child survival. There were geographical variations in U5M across the country and we identified districts from the northern, central and eastern parts to be hotspots that persisted between the two surveys. This points towards the need for implementation of strategies and targeted interventions at the subnational level to guide resource allocation to fast-track progress in reducing U5M. Even though there was significant progress in decreasing U5M between 2011 and 2015, the mortality rates remained relatively high and if Zimbabwe is to achieve SDG 3 by 2030, then fundamental steps must be taken towards tackling the U5M risk factors.