Determinants of Time-to-Under-Five Mortality in Ethiopia: Comparison of Parametric Shared Frailty Models

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ABSTRACT
This article describes how under-five mortality rate is one of the critical indicators of development of a country. This rate tells of children’s access to basic health interventions such as vaccinations, medical treatment and adequate nutrition. This article proposes to identify the determinants of time to under-five mortality in Ethiopia based on the 2014 data taken from the Ethiopian Mini Demographic and Health Survey of women of the age group 15-49 years. In this survival quantitative analysis, this article considers relevant socioeconomic, demographic variables and environmental factors. Various parameters shared among frailty models are employed to identify the determinants of Time-To-Under-Five Mortality of Ethiopia. The selection of the best-fit survival model is done by applying the Akaike information criterion (AIC). The AIC prevailed that the Weibull-gamma multivariable-shared frailty model is relatively the best-fit model. The estimation result of the Weibull-gamma multivariable-shared frailty model predicted that the major factors identified for under-five mortality in Ethiopia were mothers’ educational level, mothers’ age at first birth, place of residence, household size, sex of child born, preceding birth interval, economic status of family, place of delivery, marital status of family, and source of drinking water. The result implied that vast work is expected from governmental and non-governmental bodies to reduce the under-five mortality in the country by considering the identified factors.

KEYWORDS
Ethiopia, Frailty Models, Survival Data Analysis, Time-to-Under-Five Mortality

1. INTRODUCTION
Under-five mortality is one key indicator of development and a critical component of the millennium development goals (MDGs) for the reduction of child mortality. It tells of children’s access to basic health interventions such as vaccinations, medical treatment and adequate nutrition (WHO, 2013). Reducing childhood mortality is a focus of communities and governments all over the world. From 1990 to 2015, 62 of the 195 countries with available estimates met the Millennium Development Goal (MDG) 4 target of a two-thirds reduction in the under-five mortality rate between 1990 and 2015.

DOI: 10.4018/IJBCE.2018010101

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Among them, 24 are lower and lower-middle income countries. According to preliminary estimates, the global under five mortality rate has declined by more than half, dropping from 90 to 43 deaths per 1,000 live births between 1990 and 2015. In most regions, current trends were not sufficient to meet the MDG 4 target. At today’s rate of progress, it will take about 10 more years to reach the global target (UNICEF, 2015).

Large and increasing differences are observed in childhood mortality among world regions. Under five mortality remains a great concern for many countries in the sub Saharan region (World Data Bank, 2013). Ethiopia made a commitment to reduce under five mortality rates by two thirds by 2015. As a signatory to this Millennium Development Goal, Ethiopia is the one among 12 low-income countries who have reduced under-five mortality by two thirds and achieved the MDG 4 target set in 2000 (UNICEF, 2015). In addition to this, surveys conducted in 2000, 2005 and 2011 showed under-five mortality rates in Ethiopia have continuous declining trend.

Under-five mortality rate varies across different physical, ecological, and political structures within countries. In this study, we divided the population is into clusters, so that subjects from the same cluster were behaving more cohesively than subjects from different clusters. As a result, shared frailty models explored assuming that children within the same cluster (region) shares similar risk factors, which will be taken care of the frailty term at regional level. This model is a conditional independence model where the frailty is common to all individuals in a cluster and therefore responsible for creating dependence between event times. This is because ignoring the full dependence among observations may lead to standard errors that are understated, parameter estimates that are both biased, and inconsistent (Antai, 2011; Montgomery and Hewett, 2005; Wang, 2002; Sastry, 1997).

This paper is conducted to identify the determinants of time-to-under-five mortality in Ethiopia and to compare various parametric shared frailty models using the 2014 Ethiopian Mini Demographic and Health Survey (EMDHS) data that was conducted under the aegis of the Ministry of Health and implemented by the Central Statistical Agency (CSA) to close the knowledge gap in the study subject.

2. THE PROBLEM

Many scholars using logistic regression and semi-parametric proportional hazard models have conducted studies to identify covariates of under-five mortality in Ethiopia. However, logistic regression modelling does not account the censoring observations. That is, logistic regression modelling does not hold for time-to-event data, and in demographic applications, nonparametric and semi-parametric models are often used to model transition data. In such applications, the model assume that all heterogeneity captured by theoretically relevant covariates (Trussell and Richards, 1985; Trussell and Rodriguez, 1990). In many situations, however, there are ample reasons to suspect omitted or unmeasured factors. That is, while some individuals will be more at risk of experiencing the event, it is unlikely the underlying reasons for this variability captured by the observed covariates. If there is unmeasured frailty, the hazard will not only be a function of the covariates but also of the frailty. To assess the true effects of the observed covariates under this circumstance, some have stressed the need to explicitly account for unobserved heterogeneity. Indeed, results from several empirical and simulation studies have shown that accounting for unobserved heterogeneity significantly improves overall model fitness (Aalen 1994; Baker and Melino 2000; Blossfeld and Hamerle 1992; Heckman et al., 1985; Lancaster 1990; Manda and Meyer 2005; Vaupel et al., 1979).

In this study, we assume that clustering (frailty) has an effect on modeling the determinants of time to under-five mortality, which might be due to the heterogeneity in regions of study. As a result, shared frailty model approach is relatively better to determine covariates related to under-five mortality in helping the concerned body of the Ethiopian Government.

The general objective of this study is to model the determinants of time-to-under-five mortality. Specifically, we try to identify variables that are significantly associated with time-to-under-five mortality after comparing various parametric shared frailty models.
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