Research title on Multilevel Modelling of Time to Death for Under-Five Children: 2016 Ethiopia Demographic and Health Survey, 2019

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Abstract

Background: *Reducing child mortality is now a global concern. Globally, Under-five child mortality rate was decreased by 58% in 2017. In the 2016 EDHS report, under-five mortality was declined to 60% in Ethiopia in 2016.*

Methods: *The data for the study was obtained from EDHS data conducted in 2016. In the study, we analysed the data using stratified Cox proportional hazard model and multilevel lognormal parametric survival model.*

Results: *From the total of 10,331 under-five children, 635 (6.1%) deaths had occurred in the 2016 EDHS data. And, the overall probability of survival value was near to 0.92 with the estimated mean survival time was 55.4 months. In the study we found that covariates like birth type of the child, family size, wealth index, frequency of listening radio, place of delivery, place of residence, and geographical region were significant factors for the death of under-five children in stratified Cox proportional hazard model. In the multilevel lognormal parametric survival model, we found that the random-intercept effects of variations between region and household levels on the mean survival times of the children were 1.7 and 0.9, respectively. These values indicated that we had enough evidence for the existence of unobserved heterogeneities between regions and households.*

Conclusion*: The covariates like birth type of the child, family size, wealth index, frequency of listening radio, place of delivery, place of residence, and geographical region covariates were significant factors for under-five children mortality using stratified Cox proportional hazard regression model. In the random-intercept effects model, the two estimated variances of the random-intercept effects for regional and household levels were 1.7 and 0.9, respectively. The values indicate that we have enough evidence that there were unobserved heterogeneities on the mean survival times of the under-five children between regions and households levels. Further studies should be conducted to identify the individual, household, and community-level factors associated with infant and child mortality in Ethiopia.*

Background

Reducing child mortality is now a global concern. Globally, Under-five child mortality rate has decreased by 58%, from an estimated rate of 93 deaths per 1000 live births in 1990 to 39 deaths per 1000 live births in 2017. In Sub-Saharan Africa and South-East Asia still carry the burden of 80 percent of all global under-five deaths. Those two regions share nearly the same part: 39 percent of all deaths occurred in southern Asia whereas 38 percent occurred in sub Saharan region. The astounding thing is that among 5 countries whose half of the global under-five deaths three of them is part of sub-Saharan countries; those are Nigeria, Ethiopia, and Congo Democratic Republic (1).

As the 2016 EDHS report, under-five mortality declined from 166 deaths per 1,000 live births in 2000 to 67 deaths per 1,000 live births in 2016. This represents a 60% decrease in under-five mortality over a period of 16 years. The report also shows that there were regional disparities problems on under-five children

mortality in Ethiopia. And the mortality rates among children under age five have been interpreted as there were seven regions have observed that their children death rates were above the average rate (84 deaths per 1, 000 live births). These top 7 regions were Affar, Benishangul-Gumuz, Somali, Dire Dawa, Gambela, SNNP, and Amhara have recorded 125 deaths, 98 deaths, 94 deaths, 93 deaths, 88 deaths in each, and 85 deaths per 1, 000 live births, respectively. But, the lowest deaths rate has been observed in Addis Ababa City; it was 39 deaths per 1,000 live births(CSA and ICF, 2016). And addition to this report, other studies also shown that there was much regional variation on the incidence rate of under-five mortality in Ethiopia (3–5).

As we have seen that one study has used the EDHS data of 2016 on under-five children mortality previously. The study showed that there was an existence of unobserved heterogeneity at the regional level using Cox and Frailty models (3). In their study, they have found five significant factors for the under-five children deaths using semi-parametric gamma frailty model (used two levels). While in our study we found six additional significant factors like number of aged 5 and U5 children, children size at birth, months of breastfeeding, family size, place of delivery, and frequency of following media (like listening of radio) for the under-five children deaths using multilevel lognormal parametric survival model. And in our study we have considered the multilevel lognormal random-intercept effects model (considered three levels) and the model found that there were two estimated variances of the random-intercept effects for regional and household levels. These variations indicated that there were existences of unobserved heterogeneities between regions and households on the mean survival times of the under-five children. Those all are the gabs between the previous study and our study. The objective of the study was to determine risk factors for the under-five children deaths using multilevel fixed effect parametric survival model and to compare variations of random-intercept effects between region and household levels.

Methods

Data and Study Population

The data for this study were taken from the 2016 Ethiopian Demographic and Health Survey. The 2016 EDHS was the fourth comprehensive and nationally representative survey conducted in Ethiopia as part of worldwide Demographic and Health Surveys project. The EDHS 2016 data were downloaded from the DHS website after being granted permission. More detailed information on DHS survey design and child mortality data has been summarized in (CSA and ICF, 2016). Two stage sampling method was used. In the first stage, 645 enumeration areas (202 in urban areas and 443 in rural areas) were selected with probability proportional to the enumeration area size and with independent selection in each sampling stratum. A household listing operation was carried out in all the selected enumeration areas from September to December 2015. In the second stage of selection, a fixed number of 28 households per cluster were selected with an equal probability systematic selection from the newly created household listing. Finally, a nationally representative sample of eligible 16,650 households, and 15,683 women were

interviewed. The DHS data of children under-five were used for the statistical analysis was total of 10,331 children under age five were eligible in our study.

Outcome variable

The response variable considered in the study was the survival time of a child measured in months from birth until death/censor of children aged less than 60 months. The children who lived start within the reference period are taken into consideration. Children died within the reference period were taken as uncensored cases the children alive in that period were censored cases.

Explanatory variables

The potential explanatory variables were considered in the study were clearly stated (Table 1).

Table 1
All variables related to under-five children death.

No.	Variables	No.	Variables
1.	Age of child	13.	Fathers' education levels
2.	Survival Status of U5 Children	14.	Family size
3.	Sex of child	15.	Relationship to household
4.	Number of 5 & under 5 children	16.	Occupation in the last 12 months
5.	Type of birth	17.	Cooking fuel
6.	Birth order	18.	Frequency of listening radio
7.	Size of child at birth	19.	Wealth index
8.	Months of breastfeeding	20.	Place of delivery
9.	Under-five child type	21.	Source of drinking water
10.	Mother's age	22.	Toilet facility
11.	Current Marital status	23.	Place of residence
12.	Mothers' education levels	24.	Region

Statistical Analysis

The analysis was done by descriptive statistics, survival curves and model building analysis.

Cox proportional hazard regression model

The Cox proportional hazard regression model was used for analyzing survival data. It was used to check the existing association between child mortality and life time variables found to have a significant association with child mortality. The Cox proportional hazard model used in this study has the following form:

$$h_i(t) = h_0(t) * \exp(\beta_1 X_1 + \beta_2 X_2 + \beta_3 X_3 + \cdots \beta_P X_P)$$

Where: $h_i(t)$ is hazard of death for the ith child at time t, $h_0(t)$ is the baseline hazard at time t for X = 0, β is the vector of unknown coefficients of independent variables ($X_1, X_2, X_3 \ldots, X_P$), and e^{β_i} is the hazard ratio.

Multilevel Mixed Effects Parametric Survival Models

The mixed-effects survival models contain both fixed effect and random-intercept effects. The observations in the same cluster are correlated because they share common cluster-level random effects. In our study, we have used three-level random-intercept effect model with households nested within regions. The two often-used models for adjusting survivor functions for the effects of covariates are the accelerated failure-time model and the proportional hazards model. In this model, the covariates have a multiplicative effect on the hazard function for some baseline hazard function, and it is assumed to be parametric. Thus, the mixed-effects model based on PH model was written as follow:

$$h(t_{ijk}) = h_0(t) \exp(x_{ijk}\beta + U_i + V_{j(i)}).$$

Where: For k = 1, 2,. . ., n sampled under-five children on j = 1,. . ., m_i households nested within i = 1, 2, ..., 11 regions in Ethiopia. The 1xp row vector x_{ijk} contains the covariates for the fixed effects, with regression coefficients (fixed effects) *β*. The two random effects U_i (region level) and $V_{j(i)}$ (household level) were used to represent random intercept effect and random coefficients effect. Those random effects u_i and $v_{j(i)}$ were realized from a multivariate normal distributions with mean 0, and variances matrixes Σ, respectively.

The five commonly known parametric survival regression models are exponential, gamma, log-logistic, lognormal, and Weibull (Table 2).

Table 2: Baseline Hazard distribution for parametric models

Model	f(t)	S(t)	Parameterization	Parameter
Exponential	$\lambda \exp(-\lambda t)$	$\exp(-\lambda t)$	$\lambda = \exp(x\beta)$	λ
Weibull	$\gamma\lambda t^{\gamma-1}\exp(-\lambda t^{\gamma})$	$\exp(-\lambda t^{\gamma})$	$\lambda = \exp(x\beta)$	λ, γ
Log-logistic	$\frac{\lambda^{1/\gamma} t^{1/\gamma - 1}}{\gamma\{1 + (\lambda t)^{1/\gamma}\}^2}$	$\{1 + (\lambda t)^{1/\gamma}\}^{-1}$	$\lambda = \exp(-x\beta)$	λ, γ
Log-normal	$\frac{1}{t\sigma\sqrt{2\pi}} \exp\left[\frac{-1}{2\sigma^2}\{\log(t) - \mu\}^2\right]$	$1 - \phi\left\{\frac{\log(t) - \mu}{\sigma}\right\}$	$\mu = x\beta$	μ, σ

Results

Descriptive statistics for children characteristics’

From the total of 10,331 under-five children, 635 (6.1%) deaths had occurred in the 2016 EDHS data. And, the average age and standard deviation of the children were 27.2 and 17.9 months respectively. From the sex types of children, the male group has the highest under-five children deaths of proportion (7.1%) as compare to the female group (5.2%). Children born as a result of multiple births recorded the highest percentage (21.4%) of death compare to those as a result of a single birth (5.7%). Out of 3,867 children, 11.2% had died due to less than two children of aged five and under in house. This was the highest proportion of death as compare to two and above children of aged five and under (3.1%) in house. When we compared the birth orders of the children, the 7th and above birth order has the highest under-five children deaths proportion (7%). From 2,922 under-five children, 7.5% were died because of below the average size of the children at birth. This proportion was the highest one as compare to the average and above the average sizes of the children at births. The highest death proportion (11.9%) has occurred due to the children had been fed less than six months as compare to those had been fed for six and above months. And, as we have compared the types of under-five children, the infant group has the highest deaths of proportion (19.3%) whereas the child group has only 1.7% deaths of proportion (Table 3).

Table 3
Summary statistics for percentage of deaths of under-five children in the covariates

Covariate	Category	Total	% of Death
1. Survival Status of under-five Children	*Censored*	*9696*	*0*
	Death	635	6.1
	Total	10,331	6.1
2. Age of children	*Mean*	*27.2 months*	
	SD	*17.9 months*	
3. Sex of child	Male	5316	7.1
	Female	5015	5.2
4. Number of 5 & under 5 children	< Two children	3867	11.2
	≥ Two children	6464	3.1
5. Type of birth	Single	10060	5.7
	Multiple	271	21.4
6. Birth order	1st	2062	6.6
	2nd or 3rd	3253	5.4
	4th to 6th	3304	6.1
	7th & above	1712	7
7. Size of child at birth	< Average	2922	7.5
	Average	4304	5.2
	> Average	3105	6.2
8. Months of breastfeeding	< 6 months	1600	11.9
	≥ 6 months	8731	5.1
9. Under-five children type	Infant	2611	19.3
	Child	7720	1.7
10. Mother's age	15–24	2465	6.5
	25–34	5377	5.7
	≥ 35	2489	6.8
11. Current Marital status	Married	9903	6.2
	Others	428	5.8

Covariate	Category	Total	% of Death
12. Mothers' education levels	No education	6651	6.3
	Primary	2599	5.7
	Secondary	712	5.9
	Higher	369	7.3
13. Fathers' education levels	No education	4872	6.5
	Primary	3158	6
	Secondary	977	4.8
	Higher	744	6.3
14. Family size	1 to 3	1192	12
	4 to 6	5173	5.9
	≥ 7	3966	4.7
15. Relationship to household	Head	1739	6
	Wife	7701	6.1
	Other	891	6.8
16. Respondent's occupation in the last 12 months	Working	4217	5.9
	Not working	6114	6.3
17. Cooking fuel	Electricity	478	4.4
	Wood	8258	6.3
	Others	1595	6
18. Frequency of listening radio	Not listening	7868	512(6.5)
	Less than once a week	1241	67(5.4)
	At least once a week	1222	56(4.6)
19. Wealth index	Poor	5609	7.1
	Middle	1438	5.6
	Rich	3284	4.8
20. Place of delivery	Public sector	2956	4.4
	Private sector	7042	7
	Home	333	4.2

Covariate	Category	Total	% of Death
21. Source of drinking water	Protected	6103	5.5
	Unprotected	4228	7.1
22. Toilet facility	Flush toilet	404	3.5
	Pit latrine	5164	5.5
	No facility	4763	7
23. Place of residence	Urban	1892	3.5
	Rural	8439	6.7
24. Region	Addis Ababa city	442	3.2
	Afar	1025	8.8
	Amhara	960	5.1
	Benishangul	862	7.4
	Dire Dawa	530	5.8
	Gambela	675	6.5
	Harari	593	6.9
	Oromia	1544	5.6
	SNNPR	1242	5.7
	Somali	1440	7.2
	Tigray	1018	4

Kaplan–meier Survival Estimate Curves

The overall probability of survival value was near to 0.92 with the estimated mean survival time was 55.4 months. And, the probability of survival (0.703) for infants aged below 1 year was less than that of the probability of survival (0.98) for children aged between 1 and 5 years with the estimated mean survival times ages were 8.9 and 58.2 months, respectively (Figs. 1 & 2).

The Stratified Cox Proportional Regression Model

The Stratified Cox regression model is a modification of the Cox regression model by the stratification of a covariate that does not satisfy the proportional hazards assumption. Covariates that are assumed to satisfy the proportional hazards assumption are included in the model, whereas the predictor being

stratified is not included. Covariates like birth type of the child, family size, wealth index, frequency of listening radio, place of delivery, place of residence, and geographical region were significant factors at 5% level of significance in stratified Cox PH model (Table 4).

Table 4
Results from Stratified Cox PH Model

Risk factor	*HR*	*P-val.*	*95% CI (HR)*	
1. Type of birth (Ref: Single) Multiple	5.5	0.000*	4.153	7.350
2. Child size at birth (< average) Average	0.86	0.121	0.706	1.041
> Average	1.01	0.952	0.820	1.235
3. Age of mother (15–24) 25–34	1.2	0.121	0.957	1.457
≥ 35	1.2	0.281	0.891	1.486
5. Family size (1 to 3) 4 to 6	0.77	0.026*	0.616	0.969
≥ 7	0.69	0.008*	0.525	0.906
6. Wealth index (Poor) Middle	0.77	0.059	0.593	1.010
Rich	0.68	0.003*	0.535	0.877
7. FrEq. listening radio (No listening) once a week	0.80	0.087	0.620	1.033
At least once a week	0.70	0.012*	0.532	0.926
8. Place of delivery (Public sector) Private sector	1.6	0.000*	1.302	2.039
Home	0.93	0.816	0.527	1.656
9. Source of drkng water (Protected) Unprotected	1.1	0.378	0.909	1.286
10. Place of residence (Urban) Rural	1.5	0.013*	1.090	2.086
11. Region (Addis Ababa city) Afar	2.0	0.030*	1.068	3.722
Amhara	0.96	0.895	0.503	1.821
Oromia	1.4	0.283	0.757	2.598
Somali	1.9	0.032*	1.058	3.626
Benishangul	1.7	0.090	0.917	3.260
SNNPR	1.2	0.497	0.666	2.309
Gambela	1.3	0.371	0.704	2.561
Harari	2.0	0.033*	1.058	3.810
Tigray	0.98	0.975	0.518	1.891
Dire Dawa	1.7	0.125	0.866	3.239

Multilevel mixed-effects parametric models comparison

The mixed effects Weibull, exponential, log-normal, and log-logistic parametric regression models are fitted to find factors affecting under-five child mortality data for the fixed effects and a random effects and compared to among. On the basis of AIC criteria log-normal mixed effects model was found a best model to fit the data with minimum AIC value (4302.8) and − 2LogL value (Table 5).

Table 5
Multilevel mixed-effects parametric survival models comparison

S.No.	Model	Log-likelihood value	AIC value
1.	Log-normal	-2135.2	4318.4
2.	Log-logistic	-2141.2	4330.3
3.	Gamma	-2160.3	4368.6
4.	Weibull	-3737.8	7523.6
5.	Exponential	-3900.7	7847.4

The Multilevel Lognormal Parametric Random-intercept Model

In the three-levels mixed effects lognormal parametric model with households nested within regions, the likelihood-ratio test with the chi-square value = 20.4 and p-value = 0.000 < 5% indicated that the model with random-intercept effects model with households nested within regions fits the data better than the fixed effect model. In the fixed effects model, covariates like sex of child, number of 5 and U5 children, type of birth, size of child, months of breastfeeding, family size, listening radio, place of residence, and place of delivery were significant covariates at 5% level of significance (Table 6).

Table 6
The fitted multilevel mixed-effects log-normal parametric model results

Covariate	*B*	*SE*	*P-val*	*95% CI (B)*	
Fixed effect					
1. Sex of child (Male) Female	1.8	0.43	0.000*	0.91	2.59
2. Type of birth (Single) Multiple	-9.9	0.99	0.000*	-11.9	-7.99
3. Number of children 5&U5 (≤ Two) ≥Three	7.8	0.56	0.000*	6.60	8.77
4. Child size at birth (< average) Average	1.1	0.52	0.031*	0.11	2.15
> Average	-0.1	0.56	0.925	-1.04	1.14
5. Months of breastfeeding (≤ 6) > 6 months	8.1	0.53	0.000*	7.09	9.16
6. Family size (1 to 3) 4 to 6	1.6	0.66	0.018*	0.27	2.85
≥ 7	2.2	0.78	0.005*	0.65	3.69
7. Wealth index (Poor) Middle	1.3	0.72	0.078	-0.14	2.67
Rich	1.1	0.70	0.110	-0.25	2.49
8. FrEq. listening radio (No listening) once a week	1.3	0.68	0.067	-0.09	2.59
At least once a week	1.7	0.72	0.021*	0.25	3.07
9. Place of delivery (Public sector) Private sector	-1.8	0.59	0.002*	-3.01	-0.66
Home	-0.98	1.4	0.496	-3.82	1.85
10. Source of drkng water (Protected) Unprotected	-0.52	0.47	0.275	-1.45	0.42
11. Toilet facility (Flush toilet) Toilet latrine	-1.8	1.4	0.224	-4.55	1.07
No facility	-1.7	1.5	0.246	-4.58	1.17
12. Place of residence (Urban) Rural	-3.3	0.87	0.000*	-5.02	-1.60
Constant	11.9	1.8	0.000	8.28	15.5
/logs	2.33	0.04	0.000	2.25	2.41
Random-intercept effects					
Region: variance (cons)	**1.7**	*0.98*		*0.57*	*5.29*
Region > household: variance (cons)	**0.9**	*3.2*		*0.001*	*891.5*
LR test vs. Lognormal model: chi-sq value = 20.4		p-value = 0.000			

Discussion

In our study using the Stratified Cox PH model, the multiple or twin birth type children had more than 5 times higher risk of death compared with single birth type children. Many studies showed that birth type of child was a significant determinant factor (8–10). But, other study from Nigeria had reported the reverse of this result. The odd of having infant/child mortality was 1.87 times greater for children with single births as opposed to those with multiple births (11).

In the study, children from family sizes of 4 to 6 members and above 6 members had 0.77 and 0.69 times low risk of dying before the age of five as compared to children from family sizes of 1 to 3 members, respectively. This is consistent with a study by (8). But contradict with the study by Gebretsadik carried out in Ethiopia found an inverse relationship between under-five mortality and family size in 2011 Ethiopia demography and health Survey data (10).

Children from rich wealth index households had 0.68 times lower risk of dying before the age of five as compared to poor wealth index households. They had decreased the death rate by 32%.This was consistent with the findings by some previous studies. These households have better housing conditions, better nutrition, and hence they may be able to afford better medical attention and care thus significantly enhancing the survival probability of all their children (Bello and Joseph, 2014; O et al., 2016; Yu et al., 2018).

In our study, children were delivered in private health sector had 1.6 times high likely of dying before celebrating their 5th year of birth than children were delivered in public health sector. They had increased the death rate by 60%.But, there was no statistically significant difference between children were born in home with compared children were born in public health sector. This finding inconsistent with prior studies by (14–16).

In the study, children from parents were listening radio for at least once a week had 0.7 times less likely to die than children from parents were not listening radio. They had decreased the death rate by 30%.This study explicitly shows the existence of inconsistency in the distribution of under-five mortalities with a study (17).

Our study suggests that mortality rate was higher in rural area. This is on the ground that those living in the urban area have access to improved water supply, improve sanitation facilities, unlimited access to healthcare as well as other social and economic services. Thus, the likelihood of under-five mortality was 1.5 times high among children residing in rural areas as compared with their urban counterpart. This concurs with previous studies in and outside Ethiopia (4, 10, 16, 18).

Our findings showed that the under-five children from Afar, Somali and Harari geopolitical regions of Ethiopia were significantly associated with the highest likelihood of under-five death as compared with children from Addis Ababa city. This high risk might be attributed to social improvement in the community, population density, territorial advancement, as well as regional economic resources (5, 19–21).

In our study using the multilevel mixed-effects using the lognormal parametric model, in the fixed-effect model the covariates like child's sex, number of children aged 5 and U5, type of birth, size of child at birth, months of breastfeeding, family size, wealth index, place of delivery, place of residence, and frequency of listening radio were the risk factors for the mean survival times of under-five children at 5% level of significance. Other similar findings also found that factors such as child's sex, type of birth, total number of children, breastfeeding, size of child at birth, family size, wealth index, place of delivery, type of residence, and frequency of listening radio were found as a significant factors (3, 16, 17, 21, 22).

In our study, the mean survival time of female children is exp (1.8) = 6.05 times longer than male children with 95% CI is between 2.5 and 13.3. A similar study using the analysis of 28 Demographic and Health Surveys in Sub-Saharan Africa countries, and other study from Uganda showed that female children had reduced risks of dying before 5 years of age compared to male children (16, 23).

The mean survival time for multiple birth type of the children was exp (-9.9) = 0.034 times less than single birth type of children with 95% CI was between 0.02 and 0.06. This result was consistent with the studies (5, 24).

In the multilevel lognormal parametric model, the two estimated variances of the random-intercept effects in the mean survival times of under-five children between regions and households are 1.7 and 0.9, respectively. These indicated that we have enough evidence for the existence of unobserved heterogeneities between regions and households. And, there was high variation between regions as compared between households. Thus this study provided that there were unmeasured factors other than these included in our analysis that were caused the clustering of under-five children mortality in some households and regions.

This random-intercept effect between region level was supported by other similar studies using gamma frailty model which found that the variance of the frailty term (Regional frailty) $\theta = 0.145$ with p-value < 0.05 (3) used 2016 EDHS data, and study using multilevel logistic regression model showed that the regional level variance of the under-five children mortality was 0.218 (5) used 2011 EDHS data. And, a study from Nigeria using multilevel Cox proportional hazard regression model also founded that there were regional variations in under-five children mortality based on considering community-level variables (11, 16, 21).

Conclusions

The under-five children mortality was significantly associated with birth type of the child, family size, wealth index, frequency of listening radio, place of delivery, place of residence, and geographical region covariates using stratified Cox PH regression model after stratified some covariates to hold Cox PH assumption. The multilevel mixed-effects log-normal parametric model was found the best model to fit the data with the minimum AIC and − 2LogL value as compared with the other multilevel mixed-effects parametric models. In the fixed effects model, covariates like sex of child, number of 5 and U5 children, type of birth, size of child, months of breastfeeding, family size, listening radio, place of residence, and

place of delivery were significant covariates. In the random-intercept effects model, the two estimated variances of the random-intercept effects for regional and household levels are 1.7 and 0.9, respectively. The values indicate that we have enough evidence that there were variations (unobserved heterogeneities) on the mean survival times of the under-five children between regions and households levels. Further studies should be conducted to identify and compare the significance of the individual, household, and community-level factors associated with infant and child mortality in Ethiopia.

Abbreviations

AIC
Akaike Information Criterion; CI:Confidence Interval; CSA:Central Statistics Agency; EDHS:Ethiopian Demography and Health Survey; DHS:Demography and Health Survey; SNNP:South Nation and Nationality People of Ethiopia; U5:Under-Five Children; U5:Under-Five Children

Declarations

Ethics approval and consent to participate

The study was based on publicly available data from the DHS program (permission was granted to download data). Ethical approval was the responsibility of the institutions which collected the data.

Consent for publication

It is not applicable.

Availability of data and materials

The data can be accessed from https://www.dhsprogram.com/data/dataset_admin/ login_main.cfm by registering and requesting the datasets.

Competing interests

The authors declare that they have no competing interests.

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Authors' contributions

The corresponding author wrote each section and performed the analysis more. The co-author acquired the data, and edited the data. Both authors designed the research problems, and discussed the methodology parts. And, the corresponding author contributed extensively to the work presented in this paper. Finally, both authors read and approved the final manuscript.

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Figures

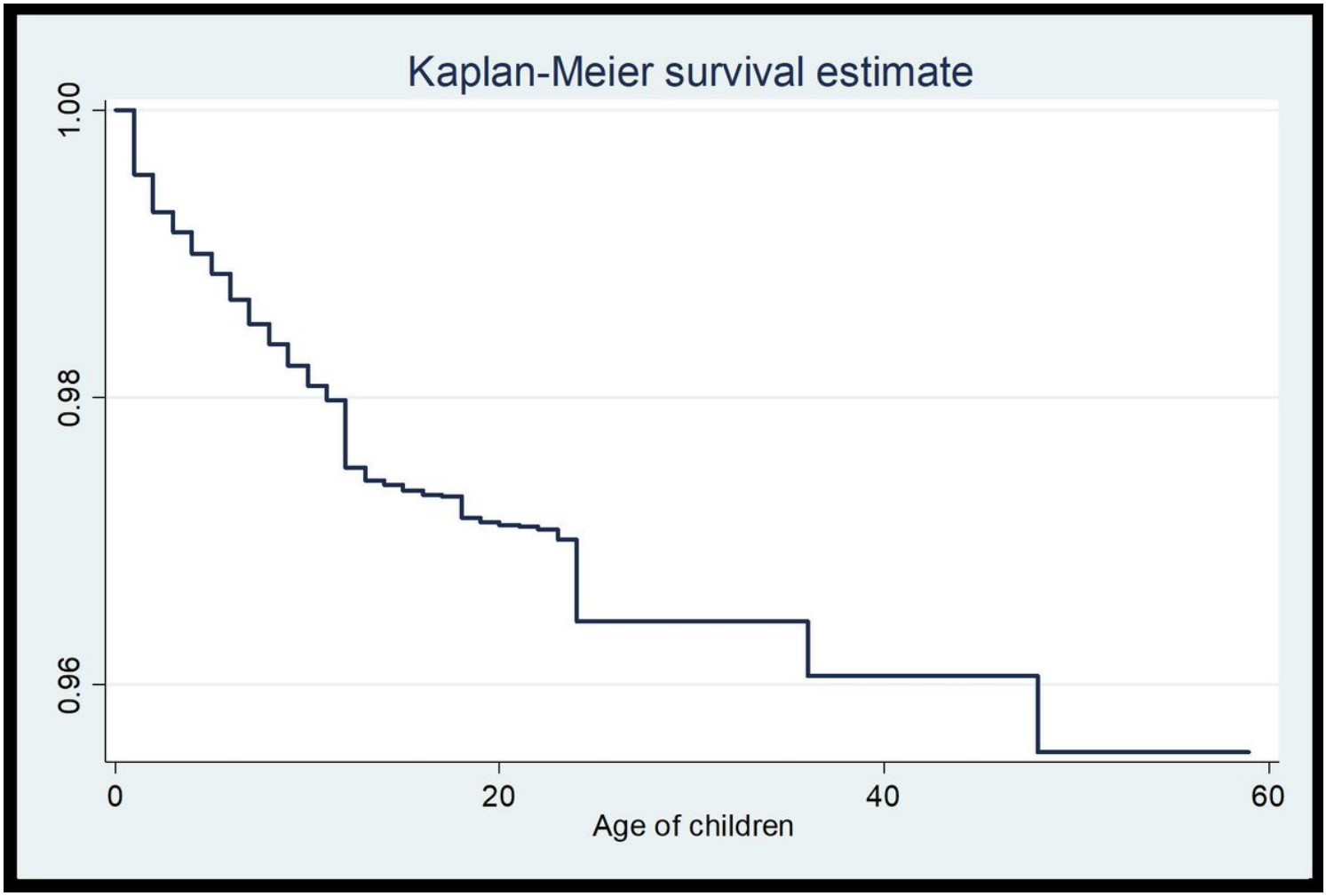

Figure 1

The overall estimate of Kaplan-Meier survivor function curve of under-five children.

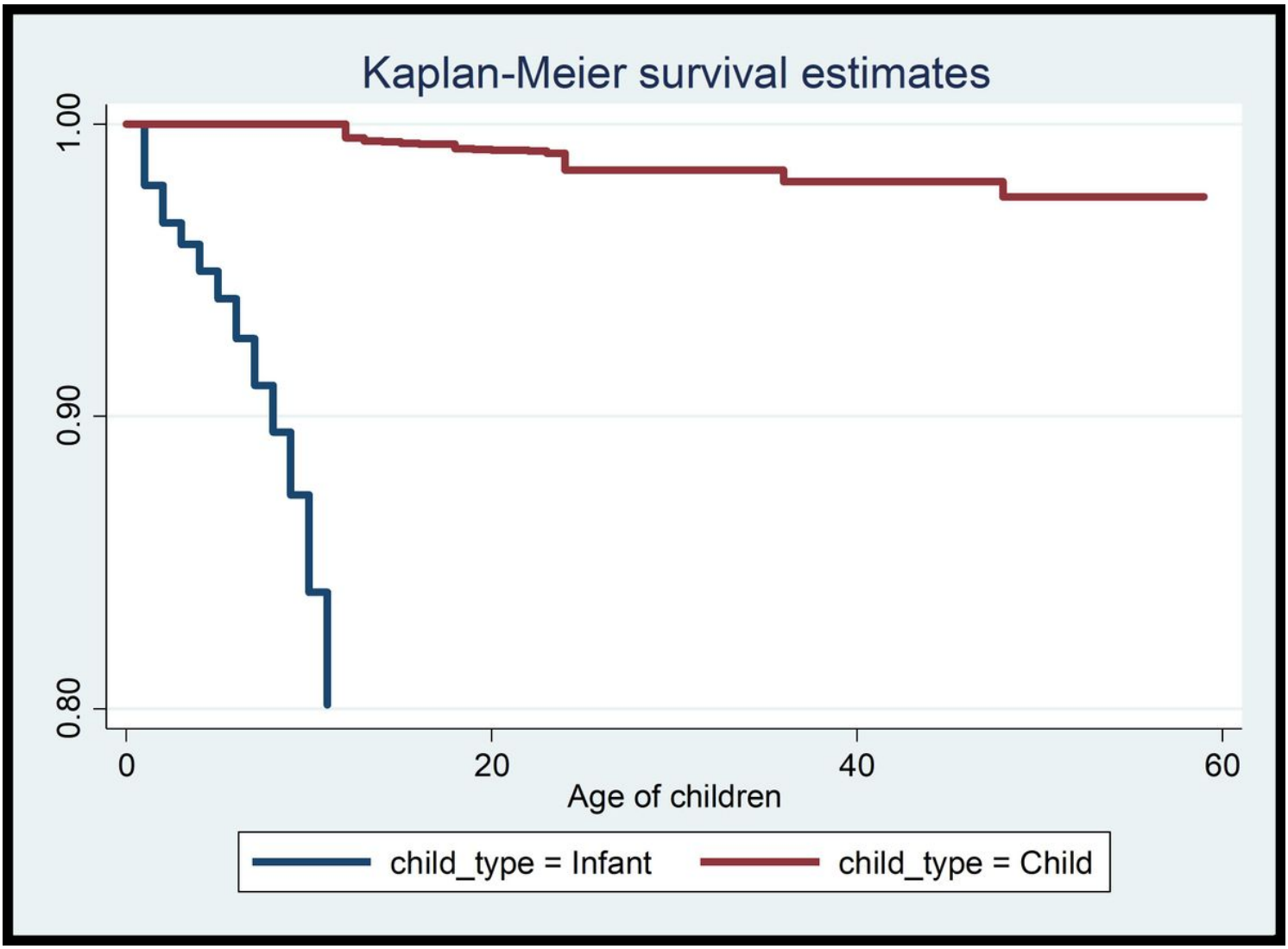

Figure 2

The overall estimate of Kaplan-Meier survivor function curves by child type.