

Brass logit system model life tables for Ethiopia

Extended Abstract

Introduction:

Over the years, model life tables played an important role in understanding the age-sex patterns of mortality for the countries/sub units of those countries where there is a dearth for reliable age-sex data on mortality, for instance Ethiopia in specific. Recent times a number of new model life table systems were invented to serve the needs of those countries (See: Murray et al., 2003, Clark et al., 2009, Wilmoth et al., 2012). These new attempts were in fact resultant of the failure of previous studies (See: Ledermann, 1969, Brass, 1971, United Nations 1955, 1982, Coale and Demeny, 1983) to some extent. Among them the “INDEPTH Model Life Tables for Sub-Saharan Africa” by INDEPTH NETWORK worth mentioning as its specific aim is to serve the countries of African continent and also used reliable input data from the selected areas of the African countries. It also used a unique methodology, that of a modified version of the Brass relational logit system, which is simple to adopt and easy to understand. Unfortunately this august work also seems to be less utilized now a day due to obvious reasons. However, inspired by the above study, and following the methodological instructions given in it, in the present paper an attempt has been made by the present researchers to develop suitable mortality standards for Ethiopia at first, then as needed appropriate correction factors were also derived. Thus attempted to develop a model life table system for Ethiopia using the modified Brass logit system proposed in INDEPTH Model Life Tables for Sub-Saharan Africa.

Objectives:

Thus said the main objective of the present paper is to develop a model life table system for Ethiopia. Specific objective is further to provide life tables overtime for various regions in Ethiopia using the above proposed model life tables and the only information on IMR and U5MR readily available from the various DHS surveys of 2000, 2005, 2011, and 2016.

Data, methods, and Results:

The life table data on survival function l_x of Ethiopia needed for creating the model mortality standards by sex (for both sexes, males and females) were collected from the source: “United Nations, Department of Economic and Social Affairs, Population Division (2019). World Population Prospects 2019, Online Edition. Rev. 1.” This source is found suitable for the present purpose as it provides empirical life tables for Ethiopia over from 1950-1955 in the past up to 2045-2050 in the future covering the complete mortality transition period of Ethiopia as a whole. It was also observed by the present researchers that in the recent past several researchers preferred this source for its credibility in data accuracy and other related issues. Correction factors γ_x derived using exactly the same procedure suggested by INDEPTH NETWORK group.

Some of the methodological details are presented below for a better understanding of the readers. For convenience of presentation, life tables, for both sexes combined corresponding to Tigray region and also of Ethiopia as a whole only are presented in some details.

Selected Results:

Table 1: Ethiopia model mortality standards* by sex

x	Both Sexes: l_{sx}^B	Males: l_{sx}^M	Females: l_{sx}^F
0	1.00000	1.00000	1.00000
1	0.91050	0.90316	0.91812
5	0.85226	0.84397	0.86086
10	0.82939	0.82068	0.83843
15	0.81698	0.80821	0.82607
20	0.80304	0.79342	0.81301
25	0.78545	0.77337	0.79797
30	0.76578	0.75221	0.77983
35	0.74360	0.72917	0.75854
40	0.71758	0.70232	0.73336
45	0.68856	0.67154	0.70616
50	0.65671	0.63657	0.67753
55	0.61893	0.59488	0.64376
60	0.57328	0.54548	0.60192
65	0.51296	0.48169	0.54506
70	0.43383	0.40080	0.46759
75	0.33426	0.30217	0.36698
80	0.22329	0.19551	0.25162
85	0.11907	0.09968	0.13887

Note: BS=Both Sexes, M=Male, F=Female;

* : Excludes data corresponding to the time period 2000-2005 and covers 19 time period from 1950-55 to 2045-2050 and obtained simply averaging the values of l_x over time from 1950-55 to 2045-50.

Source: Computed by the authors

Table 2: Obtaining correction factors (γ_x) corresponding to given β for both sexes combined, male and female

x	γ_x (Both sees)	γ_x (Male)	γ_x (Female)
0	1.0	1.0	1.0
1	1.0	1.0	1.0
5	1.0	1.0	1.0
10	1.0	1.0	1.0
15	1.0	1.0	1.0
20	1.0	1.0	1.0
25	1.0	1.0	1.0
30	$(1.258912)+(-0.225768)*\beta$	$(1.303268)+(-0.276695)*\beta$	$(1.223054)+(-0.195222)*\beta$
35	$(1.314741)+(-0.290086)*\beta$	$(1.344337)+(-0.322071)*\beta$	$(1.266603)+(-0.232902)*\beta$
40	$(1.338931)+(-0.321364)*\beta$	$(1.373512)+(-0.359925)*\beta$	$(1.280701)+(-0.250847)*\beta$
45	$(1.369666)+(-0.362387)*\beta$	$(1.411302)+(-0.410705)*\beta$	$(1.319937)+(-0.301401)*\beta$
50	$(1.413799)+(-0.423227)*\beta$	$(1.438707)+(-0.447805)*\beta$	$(1.352387)+(-0.341289)*\beta$
55	$(1.457194)+(-0.460369)*\beta$	$(1.483835)+(-0.486384)*\beta$	$(1.404837)+(-0.414487)*\beta$
60	$(1.479095)+(-0.484185)*\beta$	$(1.499575)+(-0.500714)*\beta$	$(1.451404)+(-0.453710)*\beta$
65	$(1.482314)+(-0.482014)*\beta$	$(1.550287)+(-0.537418)*\beta$	$(1.468429)+(-0.471971)*\beta$
70	$(1.540599)+(-0.524348)*\beta$	$(1.565829)+(-0.545455)*\beta$	$(1.522750)+(-0.513302)*\beta$
75	$(1.617050)+(-0.581501)*\beta$	$(2.174584)+(-1.056923)*\beta$	$(1.529946)+(-0.506906)*\beta$
80	$(5.846868)+(-4.289768)*\beta$	$(7.154413)+(-5.428901)*\beta$	$(3.800276)+(-2.510280)*\beta$
85	$(11.344666)+(-9.178013)*\beta$	$(11.829432)+(-9.637066)*\beta$	$(11.074625)+(-8.992014)*\beta$

Source: Computed by the authors

Steps to be followed in estimating survival function (l_x) from the only given information on IMR (or ${}_{1q_0}$) and U5MR (or ${}_{5q_0}$) [Adopted from "INDEPTH Model Life Tables for Sub-Saharan Africa, INDEPTH Network, P. 29.]

- 1) Compute l_1 and l_5 as : $l_1 = 1 - {}_{1q_0}$; $l_5 = 1 - {}_{5q_0}$
- 2) Decide above the standard mortality table to be used (Both sexes or male or female) and choose l_{s1} and l_{s5} and obtain α and β using the following formulae:

$$\beta = [\ln ((1-l_5) l_1) / (l_5(1-l_1))] / [\ln((1-l_{s5})l_{s1})/(l_{s5}(1-l_{s1}))]$$

$$\alpha = 0.5 \times \ln ((1-l_5)/l_5) - \beta \times 0.5 \times \ln (1-l_{s5})/l_{s5}$$
- 3) Generate a first estimate of the survival curve l_x^1 corresponding to the above obtained α and β using Brass' formula given as:
 First estimate of $l_x = l_x^1 = (1 / (1+\text{Exp} (2 \alpha + \beta (\ln ((1-l_{sx}) / l_{sx}))))))$
- 4) Obtain the values of the correction factors ' γ_x ' corresponding to the above β from the corresponding factors tables (See Table 2A, Table 2B and Table 2C for both sexes combined, males and females respectively)
- 5) Divide the first estimate of l_x that is l_x^1 by the corresponding values of ' γ_x ' get the corrected first estimate of l_x
- 6) Compute the logit of the corrected first estimate of l_x and also that of logit of the standard chosen as follows:

$$\text{Logit} (l_x^1 / \gamma_x) = 0.5 \times \ln ((1 - l_x^1 / \gamma_x) / (l_x^1 / \gamma_x))$$

$$\text{Logit} (l_{sx}) = 0.5 \times \ln ((1 - l_{sx}) / (l_{sx}))$$
- 7) Obtain the new values of α and β by means of regressing $\text{Logit} (l_x^1 / \gamma_x)$ with $\text{Logit} (l_{sx})$, taking $\text{Logit} (l_{sx})$ as independent.
- 8) Obtain the final and more smoothed value of l_x curve by means of using the new values of α and β thus obtained in step 7) in the following Brass' formula:
 Final estimate of $l_x = (1 / (1+\text{Exp} (2 \alpha + \beta (\ln ((1-l_{sx}) / l_{sx}))))))$
- 9) Finally, to obtain a complete life table with all usual columns, use at first an appropriate procedure to extend the life table final estimate l_x column obtained in step 8) to age 100. You may also use LIFTB program of MORTPAK LITE package for getting the complete life table up to age 100 from final estimate of l_x given in step 8 above.

Important Reference:

INDEPTH Network (2004) INDEPTH Model Life Tables for Sub-Saharan Africa/ compiled by INDEPTH NETWORK Ghana, USA: Ashgate Publishing Company

Abridged Life Tables, Both sexes, Ethiopia

x	2000		2005		2011		2016		2019	
	lx	ex	lx	ex	lx	ex	lx	ex	lx	ex
0	100000	50.794	100000	56.368	100000	61.112	100000	63.551	100000	64.136
1	91047	54.759	93614	59.198	95252	63.150	96179	65.070	96673	65.338
5	84199	55.100	88431	58.582	91294	61.822	92849	63.348	93589	63.440
10	81430	51.889	86264	54.991	89608	57.938	91404	59.310	92224	59.342
15	79915	47.825	85062	50.732	88664	53.528	90590	54.820	91449	54.824
20	78207	43.814	83692	46.521	87580	49.159	89649	50.369	90549	50.343
25	76044	39.987	81934	42.463	86177	44.917	88423	46.031	89370	45.973
30	73619	36.220	79932	38.463	84564	40.725	87002	41.741	87994	41.652
35	70883	32.519	77634	34.525	82688	36.591	85337	37.505	86371	37.386
40	67679	28.938	74888	30.697	80415	32.552	83298	33.360	84369	33.212
45	64120	25.403	71767	26.922	77788	28.565	80916	29.267	82012	29.093
50	60246	21.872	68283	23.164	74798	24.604	78172	25.204	79275	25.008
55	55707	18.445	64083	19.513	71109	20.746	74739	21.242	75823	21.028
60	50328	15.140	58931	15.992	66456	17.016	70334	17.408	71357	17.180
65	43434	12.130	52042	12.762	59997	13.563	64089	13.847	64964	13.609
70	34830	9.490	42962	9.908	51039	10.482	55182	10.655	55762	10.418
75	24823	7.294	31676	7.525	39130	7.883	42916	7.954	43010	7.733
80	14889	5.520	19643	5.611	25359	5.794	28171	5.790	27728	5.600
85	6894	4.189	9321	4.189	12537	4.252	13984	4.202	13312	4.048
90	2283	3.223	3098	3.174	4271	3.168	4698	3.100	4241	2.981
95	502	2.522	662	2.452	910	2.410	961	2.339	806	2.247
100	69	1.983	85	1.863	113	1.840	111	1.785	85	1.717

Abridged Life Tables, Both sexes, Tigray

x	2000		2005		2011		2016	
	lx	ex	lx	ex	lx	ex	lx	ex
0	100000	50.550	100000	58.688	100000	61.054	100000	64.418
1	91071	54.477	94491	61.097	95075	63.207	96573	65.699
5	84161	54.836	89935	60.117	91061	61.927	93489	63.815
10	81360	51.638	88010	56.377	89363	58.056	92136	59.715
15	79827	47.581	86936	52.043	88414	53.652	91369	55.196
20	78098	43.578	85708	47.752	87327	49.288	90481	50.712
25	75907	39.761	84123	43.603	85922	45.052	89319	46.338
30	73451	36.005	82310	39.507	84310	40.864	87968	42.010
35	70679	32.317	80214	35.472	82440	36.733	86376	37.737
40	67433	28.750	77690	31.541	80177	32.697	84418	33.552
45	63829	25.230	74797	27.662	77569	28.711	82117	29.421
50	59907	21.715	71535	23.807	74605	24.749	79450	25.322
55	55317	18.303	67555	20.057	70957	20.888	76092	21.324
60	49884	15.015	62605	16.436	66363	17.153	71751	17.456
65	42938	12.023	55863	13.102	59996	13.694	65540	13.858
70	34299	9.402	46755	10.145	51174	10.601	56580	10.634
75	24308	7.227	35073	7.666	39430	7.985	44083	7.907
80	14470	5.471	22154	5.677	25779	5.877	28892	5.728
85	6635	4.155	10678	4.203	12925	4.315	14213	4.138
90	2172	3.200	3573	3.160	4493	3.214	4676	3.042
95	471	2.506	758	2.424	983	2.446	923	2.289
100	64	1.970	95	1.861	125	1.866	101	1.750

Fig: Levels and Trends in Life Expectancy at Birth (LEB), Ethiopia and Regions, 2000 to 2019

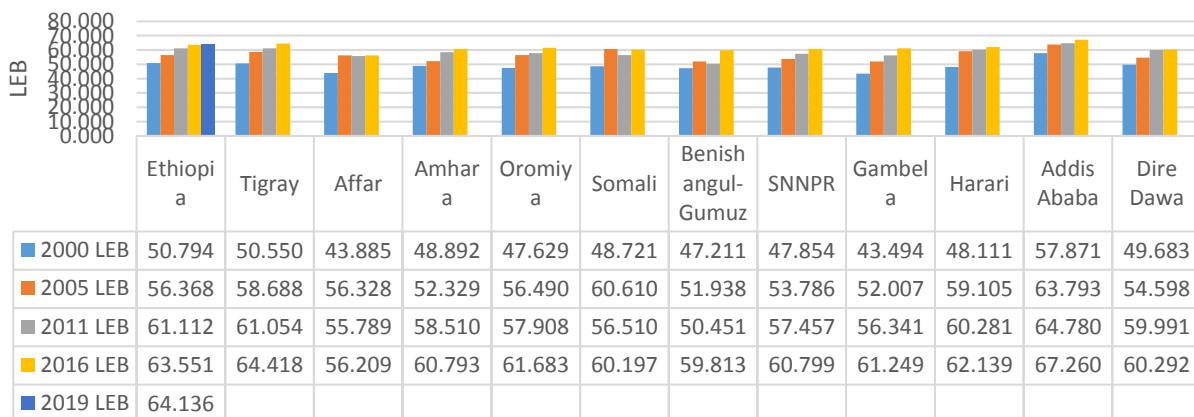


Fig: Levels and Trends in Life Epectancy at age 60 (LE60), Ethiopia and Regions, 2000 to 2019

