EXPANDING THE LIFE TABLES TO INCLUDE THE HEALTHY LIFE EXPECTANCY. THE CASE OF CZECHIA AND HUNGARY

Christos H Skiadas – Yiannis Dimotikalis

Abstract

We provide a method to expand the Life Tables to include the Healthy Life Years Lost to Disability (HLYL), to estimate the Proportion of Disability and then apply the Sullivan Method to estimate the Healthy Life Expectancy (HLE) and the Healthy Life Years Lost (HLYL). Two Templates are provided. The first Template is based on the ten-column life table from the Human Mortality Database (HMD) expanded by adding another seven columns for estimating the proportion of disability and another four columns to apply the Sullivan method for calculating the HLE and the HLYL. In the first Template all the life table from HMD is inserted, while with the second Template, only the mx column is needed or alternatively the qx column. Furthermore, the method is extended in expanding the abridged life tables as well. Abridged life tables from HMD and World Health Organisation (WHO) are expanded. Applications in Czechia and Hungary apply.

See https://doi.org/10.1007/978-3-030-44695-6_3 for details and ask about the related programs in Excel from the authors.

Key words: Life Expectancy, Healthy Life Expectancy, Life Tables, Health Parameters, Healthy Life Years Lost.

JEL Code: I15, I18, J1

Introduction and Model Building

We provide a method to expand the Life Tables in Czechia and Hungary, to include the Healthy Life Years Lost to Disability (HLYL), to estimate the Proportion of Disability and then apply the Sullivan Method (Sullivan, 1971) to estimate the Disability Free Life Expectancy (DFLE) or the Healthy Life Expectancy (HLE) and the Healthy Life Years Lost (HLYL). The main part of the

theory appears in: Skiadas, C. H., & Skiadas, C. (2020). Direct healthy life expectancy estimates from life tables with a Sullivan extension. Bridging the gap between HALE and Eurostat estimates. In The Springer series on demographic methods and population analysis 50. Springer. https://doi.org/10.1007/978-3-030-44695-6_3.

The Life Tables are provided by the Human Mortality Database (HMD) in the related website https://www.mortality.org/. The ten columns are included in the HMD life table, and the rest eight columns are completed by the authors of this paper following the theory presented by Skiadas and Skiadas in 2018a, b and 2020a, b, c.

Both life table applications in Czechia and Hungary provide important information for the health of the population. However, more information is provided by estimating not only the life expectancy but also the healthy life expectancy and the healthy life years lost and the disability percentage, by expanding the provided life tables as we do in the present paper. The expanded life tables in Czechia are presented in Figure 1 for Czechia and in Figure 2 for Czechia with a second method. The first ten columns in Figure 1 are included in the Czechia life table for males in 2019 and the rest eleven columns are completed by the authors of this paper following the theory presented by Skiadas and Skiadas in 2018a, b and 2020a, b, c.

Fig. 1: Life Expectancy (LE) and Healthy Life Expectancy (HLE) in Czechia, males 2019.

Healthy Life Expectancy (HLE) & Healthy Life Years Lost (HLYL) Progr										C. H. Skiadas & C. Skiadas. May 2022 latest				Country	Czechia	Males	2019	https://www.mortality.org/		
Manually complete the full Life Table from the Human Mortality Database, HMD (recommended) at https://www.mortality.org/ 1st TEMPLATE										Cumulative mortality Mx=Σ(dx/lx)	Average Cumulative Mortality Mx/x	Years of disability influence at age x	bx HLYL Indicator PLYL/lx	Disability Parameter	Person life years lost PLYL	Proportion with disability	Sullivan Method			
Year	Age	mx	qx	ax	lx	dx	Lx	Tx	ex	Cumulative mortality Mx=Σ(dx/lx)	Average Cumulative Mortality Mx/x	Years of disability influence at age x xdx/Mx	bx HLYL Indicator PLYL/lx bx=(xdx) / (lxMx)	Disability Parameter kD	Person life years lost PLYL (xdx/Mx)*kD	Proportion with disability PxD	Person Years Lived without disability LxD	Total Years Lived without disability TxD	Disability free life expectancy (HLE) exD	Healthy Life Years Lost HLYL
2019	0	0.0029	0.00284	0.14	100000	284	99756	7634092	76.34	0.003	0.012	24000	0.24	0.0364	875	0.009	98883	6783339	67.83	8.51
2019	1	0.0002	0.0002	0.5	99716	20	99705	7534336	75.56	0.003	0.002	9867	0.10	0.0364	360	0.004	99346	6684456	67.03	8.53
2019	2	0.0002	0.00015	0.5	99695	15	99688	7434631	74.57	0.003	0.001	11752	0.11	0.0364	428	0.004	99272	6585110	66.05	8.52
2019	3	0.0001	0.00012	0.5	99680	12	99674	7334943	73.58	0.003	0.001	12683	0.12	0.0364	462	0.004	99235	6485838	65.07	8.51
2019	4	9E-05	0.00009	0.5	99668	9	99664	7235269	72.59	0.003	0.001	11906	0.14	0.0364	434	0.005	99154	6386603	64.08	8.51
2019	103	0.5988	0.46083	0.5	84	39	65	134	1.59	6.522	0.063	619	7.32	0.0364	23	0.267	47	95	1.13	0.46
2019	104	0.6295	0.47878	0.5	46	22	35	69	1.52	7.000	0.067	328	7.15	0.0364	12	0.261	25	48	1.04	0.48
2019	105	0.6591	0.49574	0.5	24	12	18	35	1.46	7.500	0.071	169	6.98	0.0364	6	0.254	13	23	0.96	0.50
2019	106	0.6876	0.51167	0.5	12	6	9	17	1.41	8.000	0.075	80	6.81	0.0364	3	0.248	6	10	0.83	0.58
2019	107	0.7147	0.52654	0.5	6	3	4	8	1.36	8.500	0.079	38	6.63	0.0364	1	0.242	3	4	0.67	0.69
2019	108	0.7403	0.54033	0.5	3	1	2	4	1.32	8.834	0.081	12	6.46	0.0364	0	0.235	1	1	0.33	0.99
2019	109	0.7644	0.55305	0.5	1	1	1	2	1.29	9.834	0.090	11	6.19	0.0364	0	0.226	0	0	0.00	0.00
2019	110+	0.787	1	1.27	1	1	1	1	1.27	10.834	0.097	10	6.02	0.0364	0	0.219	0	0	0.00	0.00

Source: Our calculations

Figure 1 illustrates the full Expanded Life Table with Disability Section and Sullivan Section for the Healthy Life Expectancy estimation for males the 2019 in Czechia. The Life Table is provided by the HMD. The life expectancy at birth is 76.34 years of age and the Healthy Life

Expectancy is estimated for 67.83 years of age. The same estimates are provided with the second method presented in Figure 2 where only the data from mx column are used. The rest are calculated by the program with the same results as from case 1.

Fig. 2: Life Expectancy (LE) and Healthy Life Expectancy (HLE) in Czechia, 2nd method.

Estimates of HLYL and HLE (C H Skiadas and C Skiadas, 2016, first version). 2nd TEMPLATE Add mx data in this Excel file and do not change the supporting files as they run automatically										C. H. Skiadas & C. Skiadas. May 2022 - Latest				Country	Czechia	Males	2019			
Manually complete the Excel column only for mx or for qx										Cumulative mortality Mx=Σ(dx/lx)	Average Cumulative Mortality Mx/x	Years of disability influence at age x	bx HLYL Indicator PLYL/lx	Disability Parameter	Person life years lost PLYL	Proportion with disability	Sullivan Method			
Year	Age	mx	qx	ax	lx	dx	Lx	Tx	ex	Cumulative mortality Mx=Σ(dx/lx)	Average Cumulative Mortality Mx/x	Years of disability influence at age x xdx/Mx	bx HLYL Indicator PLYL/lx bx=(xdx) / (lxMx)	Disability Parameter kD	Person life years lost PLYL (xdx/Mx)*kD	Proportion with disability PxD	Person Years Lived without disability LxD	Total Years Lived without disability TxD	Disability free life expectancy (HLE) exD	Healthy Life Years Lost HLYL
2019	0	0.00285	0.00284	0.06	100000	284	99733	7634043	**76.34**	0.003	0.018	16000	0.16	0.0364	583	0.006	99151	6783499	67.83	8.51
2019	1	0.0002	0.00020	0.5	99716	20	99706	7534310	**75.56**	0.003	0.002	9832	0.10	0.0364	358	0.004	99347	6684348	67.03	8.52
2019	2	0.00015	0.00015	0.5	99696	15	99688	7434604	**74.57**	0.003	0.001	11710	0.11	0.0364	427	0.004	99272	6585001	66.05	8.52
2019	3	0.00012	0.00012	0.5	99681	12	99675	7334916	**73.58**	0.003	0.001	12639	0.12	0.0364	461	0.004	99236	6485729	65.06	8.52
2019	4	0.00009	0.00009	0.5	99669	9	99664	7235241	**72.59**	0.003	0.001	11864	0.14	0.0364	432	0.005	99155	6386493	64.08	8.52
2019	5	0.00011	0.00011	0.5	99660	11	99654	7135577	**71.60**	0.004	0.001	17165	0.21	0.0364	626	0.008	98903	6287338	63.09	8.51
2019	103	0.5988	0.46083	0.5	84	39	65	134	**1.59**	6.515	0.063	618	7.32	0.0364	23	0.267	47	95	1.12	0.47
2019	104	0.62946	0.47878	0.5	46	22	35	69	**1.52**	6.993	0.067	326	7.15	0.0364	12	0.261	25	48	1.05	0.47
2019	105	0.65912	0.49574	0.5	24	12	18	35	**1.46**	7.489	0.071	166	6.98	0.0364	6	0.254	13	23	0.97	0.49
2019	106	0.68758	0.51167	0.5	12	6	9	17	**1.41**	8.001	0.075	82	6.81	0.0364	3	0.248	6	10	0.84	0.57
2019	107	0.71469	0.52654	0.5	6	3	4	8	**1.36**	8.527	0.079	39	6.63	0.0364	1	0.242	3	4	0.68	0.68
2019	108	0.74034	0.54033	0.5	3	1.50	2.02	4	**1.32**	9.068	0.084	18	6.46	0.0364	1	0.236	1	1	0.36	0.96
2019	109	0.76444	0.55305	0.5	1	0.70	0.92	2	**1.28**	9.621	0.088	8	6.19	0.0364	0	0.226	0	0	0.00	0.00
2019	110+	0.78695	1.00000	1.2	0.57	0.57	0.70	0.70	**1.24**	10.621	0.095	6	6.02	0.0364	0	0.219	0	0	0.00	0.00

Source: Our calculations

The Life Table for Czechia is provided from the Human Mortality Database. Ten columns are provided starting from the age column, the number of persons dx died in the interval (x, x+1), the probability qx dying in (x, x+1), the Mean fraction ax of last year of life lived by persons died in [x, x + 1), the Number of person-years Lx lived in [x, x + 1), the Number of person-years Tx lived beyond x and the Life expectancy ex at x. This is the classical Life Table provided for the human population. A few years ago we expanded this life table to include the estimates of the Proportion with Disability, followed by four columns for the Sullivan Method to estimate the Healthy Life Expectancy (HLE) and the Healthy Life Years Lost (HLYL).

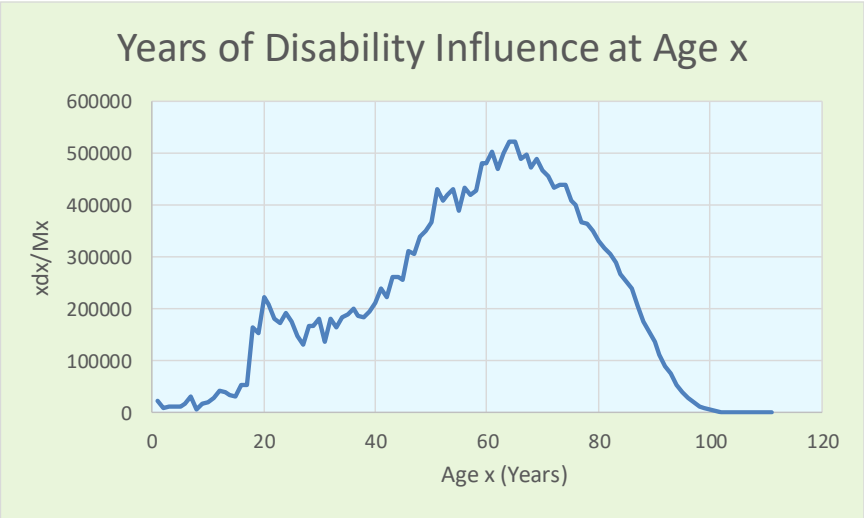
First, we calculate the years of disability influence at age x (YDIx) as

$$YDIx = \frac{(x+a_x)d_x}{\sum_0^x q_x} \qquad (1)$$

Figure 3 illustrates the form of the curve expressing the years with disability influence adopted for persons in Czechia. Then the Healthy Life Years Lost Indicator bx is calculated by dividing the YDIx by lx, the number of people living at x.

$$b_x = \frac{YDIx}{lx} \qquad (2)$$

Fig. 3: Years of Disability Influence at age x to calculate bx.



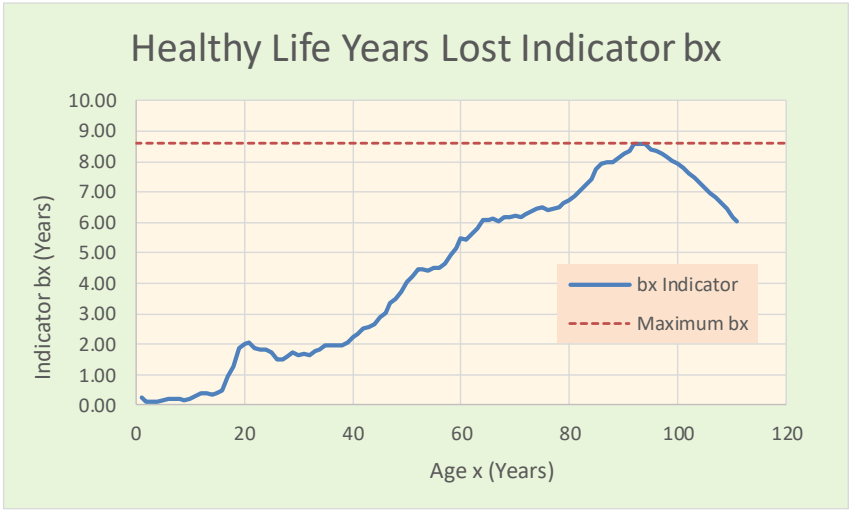
Source: Our calculations

The last formula is equal to the following to calculate to proportion of disability to form the Healthy Life Years Lost Indicator:

$$bx = \frac{(x+a_x)q_x}{\sum_0^x q_x} \qquad (3)$$

This formula provides the average of dying probability qx over the mean probability at age x.

Fig. 4: Healthy Life Years Lost Indicator bx and maximum level.



Source: Our calculations

The next column provides the disability parameter kD so that the maximum of bx=8.51 for males in Czechia is the Healthy Life Years Lost (HLYL)=8.51 at age (0-1) years.

The proportion with disability (PxD) is

$$PxD = kb_x \qquad (4)$$

After this stage, the Person Years Lived without Disability (LxD) are estimated with the Sullivan method as

$$LxD = (1 - kb_x)L_x \qquad (5)$$

The Total Years Lived without Disability (TxD) are then provided in the next column.

The Disability Free Life Expectancy or the Healthy Life Expectancy (HLE) at age x is given by

$$HLEx = \frac{TxD}{lx} \qquad (6)$$

And the Healthy Life Years Lost (HLYL) at age x are provided by

$$HLYLx = LEx - HLEx \qquad (7)$$

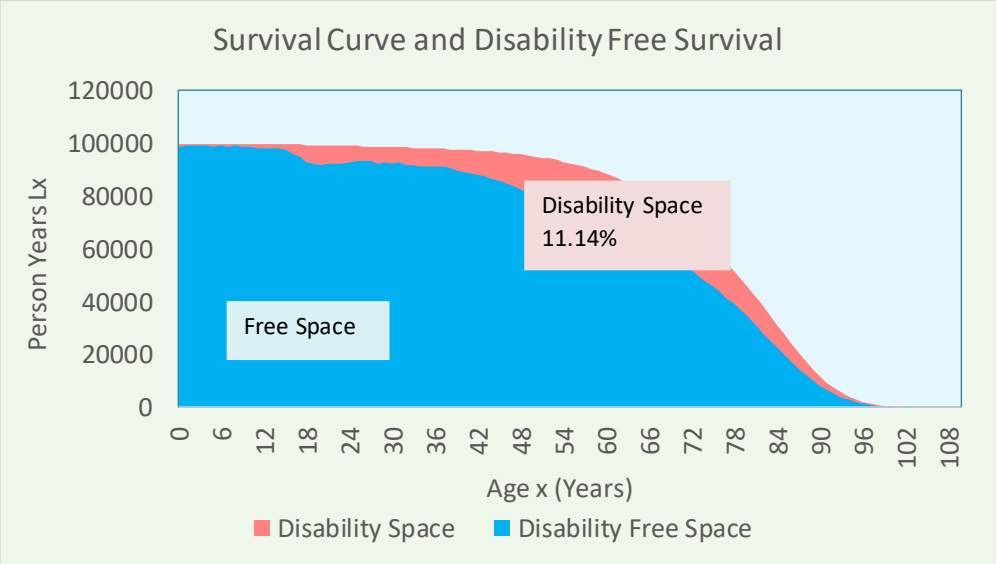
Where the life expectancy at age x is LEx=ex

The Survival vs Mortality space graph is used to provide bx to form the Healthy Life Years Lost Indicator.

More information and details for the formula needed to estimate the healthy life years lost appear in several papers by Skiadas and Skiadas in 2018a, b and 2020a, b, c.

The survival curve Lx and the disability-free survival LxD are provided in the related column of Figure 1 and illustrated in Figure 5 for males the 2019 in Czechia. The space between the survival curve and the disability free survival curve (with an orange color) corresponds to the disability period for males, while the space below the disability free survival curve (blue curve) is the healthy period for males in 2019.

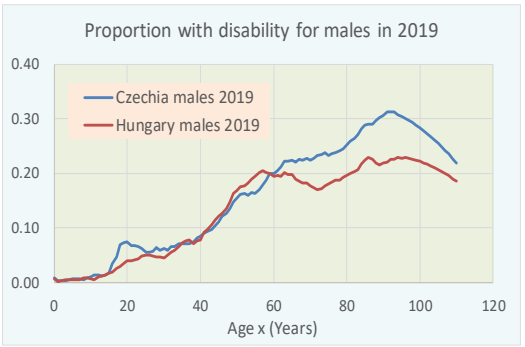
Fig. 5: Survival Curve and Disability Free Survival for males in Czechia, 2019.
Source: Our calculations

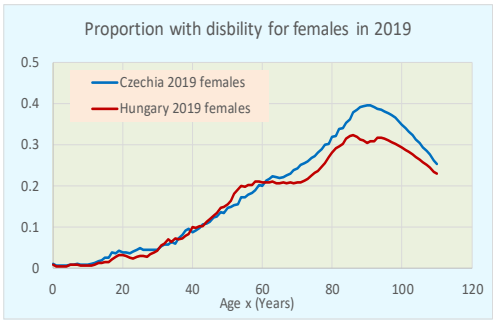


Morbidity estimates

Following our estimates from the expanded Czechia life table provided in Figure 1 the males' percentage lived with disability is 11.14%, which is around 11% (it is 9.59% for Hungary, males, 2019). Figure 6 presents the proportion of disability for males and females in Czechia and Hungary.

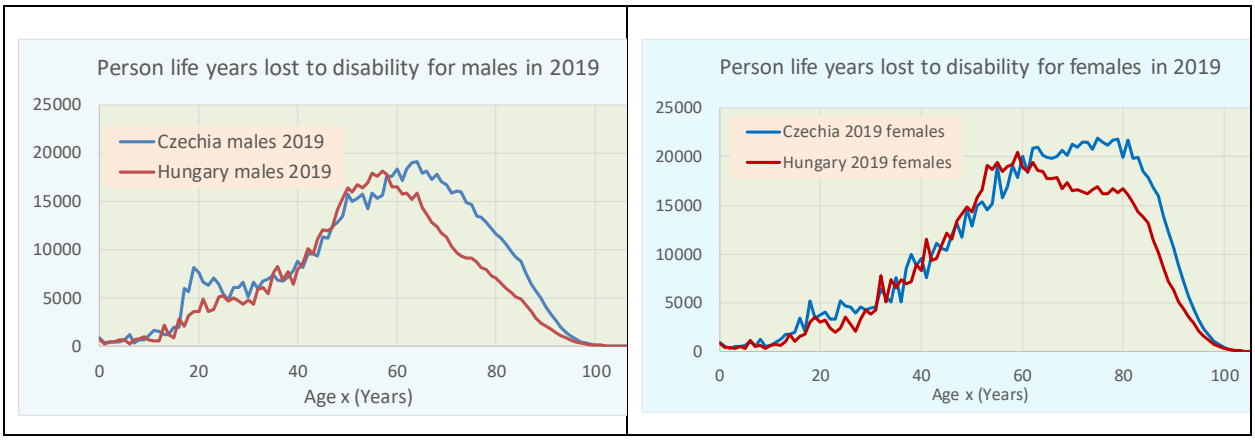
Fig. 6: Proportion of disability for males and females in Czechia and Hungary in 2019.





Source: Our calculations

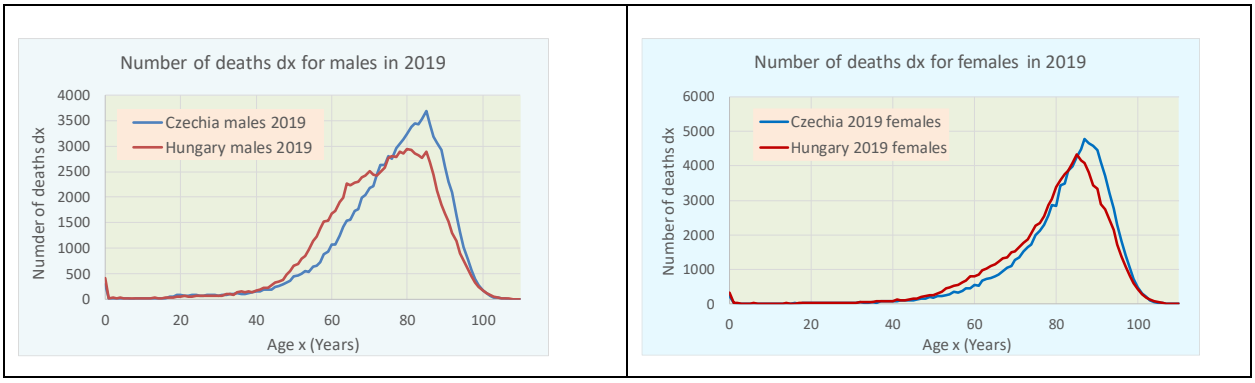
Fig. 7: Person life years lost to disability for males and females in Czechia and Hungary.



Source: Our calculations

The Person life years lost to disability for males and females in Czechia and Hungary are illustrated in figure 7 and the number of deaths dx for males and females in Czechia and Hungary in 2019 are presented in figure 8. The percentage of deaths is larger in Czechia as the population at the higher ages is larger in Czechia than Hungary for males and females in 2019.

Fig. 8: Number of deaths dx for males and females in Czechia and Hungary in 2019.



Source: Our calculations

So far, we have included the full life tables in our methodology. These life tables are more accurate when we estimate the healthy life expectancy. However, in many cases, only abridged life tables are provided. For this case we have expanded the 5year step life tables provided by HMD ranging from 0 to 110+ years of age (see figure 9) and the 5year step life tables provided by the World Health Organization ranging from 0 to 85+ years of age (see figure 10). We have checked the HLE estimates for males 2019 in Czechia by the expanded abridged life table from

HMD that are 67.94 years from the abridged HMD and 67.30 years from the abridged WHO compared to 67.83 years of age with full HMD life table expanded. The HLE estimated by WHO is 67 years for males and 70.6 years for females. In the latter case, the WHO life table expanded estimate is 70.33 years of age.

Fig. 9: Expanded Abridged Life Table from HMD. HLE in Czechia, males 2019.

Human Mortality Database (HMD) Abridged Life Table for Czechia (Males in 2019), Expanded to include the Healthy Life Expectancy Calculation																			
HMD Life Table										Proportion with Disability						Sullivan Method			
Year	Age	mx	qx	ax	lx	dx	Lx	Tx	ex	Age	mx adapt	bx	bx*Lx	k	k*bx	LxD	TxD	exD	HLYL
2019	0	0.00285	0.00284	0.14	100000	284	99756	7634092	76.34	0	0.00285	0	0	0.0383	0	99756	6794311	67.94	8.40
2019	1--4	0.00014	0.00056	1.66	99716	56	398731	7534336	75.56	1	0.00014	0.046823	18670	0.0383	0.001794	398015	6694555	67.14	8.42
2019	5--9	0.0001	0.00048	2.2	99659	48	498162	7135605	71.6	5	0.00044	0.145773	72618	0.0383	0.005585	495379	6296540	63.18	8.42
2019	10--14	0.00012	0.00061	2.37	99611	61	497895	6637443	66.63	10	0.00056	0.300752	149743	0.0383	0.011523	492157	5801161	58.24	8.39
2019	15-19	0.00042	0.00209	3.24	99550	208	497384	6139548	61.67	15	0.0015	1.147541	570769	0.0383	0.043965	475516	5309004	53.33	8.34
2019	20-24	0.00073	0.00364	2.53	99342	361	495816	5642164	56.8	20	0.00303	1.713615	849638	0.0383	0.065653	463264	4833488	48.66	8.14
2019	25-29	0.00072	0.00359	2.68	98981	355	494078	5146348	51.99	25	0.00362	1.482702	732570	0.0383	0.056806	466011	4370224	44.15	7.84
2019	30-34	0.00088	0.00438	2.67	98625	432	492120	4652270	47.17	30	0.00408	1.62762	800984	0.0383	0.062358	461432	3904213	39.59	7.58
2019	35-39	0.00116	0.00577	2.59	98194	567	489602	4160150	42.37	35	0.00524	1.891892	926274	0.0383	0.072483	454114	3442781	35.06	7.31
2019	40-44	0.00175	0.00871	2.63	97627	850	486121	3670548	37.6	40	0.00757	2.411299	1172183	0.0383	0.092383	441211	2988667	30.61	6.99
2019	45-49	0.00304	0.01508	2.71	96776	1459	480536	3184428	32.9	45	0.01262	3.284514	1578327	0.0383	0.125838	420066	2547456	26.32	6.58
2019	50-54	0.00531	0.02622	2.6	95317	2499	470599	2703891	28.37	50	0.02201	4.170594	1962677	0.0383	0.159786	395403	2127390	22.32	6.05
2019	55-59	0.0084	0.04122	2.72	92818	3826	455348	2233292	24.06	55	0.03582	4.64415	2114704	0.0383	0.177929	374328	1731987	18.66	5.40
2019	60-64	0.01474	0.07128	2.7	88992	6343	430383	1777944	19.98	60	0.06102	5.51028	2371531	0.0383	0.211113	339523	1357659	15.26	4.72
2019	65-69	0.02321	0.10999	2.63	82649	9091	391742	1347561	16.3	65	0.09911	5.811217	2276498	0.0383	0.222643	304523	1018136	12.32	3.98
2019	70-74	0.03571	0.16453	2.61	73558	12103	338878	955818	12.99	70	0.15355	6.050198	2050279	0.0383	0.231799	260326	713613	9.70	3.29
2019	75-79	0.05417	0.23929	2.56	61456	14706	271463	616940	10.04	75	0.23393	6.278493	1704379	0.0383	0.240545	206163	453287	7.38	2.66
2019	80-84	0.0888	0.36435	2.54	46750	17033	191806	345478	7.39	80	0.37474	6.952233	1333480	0.0383	0.266358	140716	247124	5.29	2.10
2019	85-89	0.1538	0.54841	2.38	29717	16297	105959	153671	5.17	85	0.639	7.871366	834042	0.0383	0.301572	74004	106408	3.58	1.59
2019	90-94	0.25503	0.7416	2.18	13420	9952	39023	47712	3.56	90	1.07269	8.396756	327667	0.0383	0.321701	26469	32404	2.41	1.15
2019	95-99	0.38447	0.87367	1.88	3468	3030	7880	8689	2.51	95	1.66347	8.306739	65457	0.0383	0.318252	5372	5935	1.71	0.80
2019	100-104	0.53514	0.94582	1.58	438	414	774	809	1.85	100	2.37436	7.903003	6117	0.0383	0.302784	539	563	1.29	0.56
2019	105-109	0.68128	0.97605	1.35	24	23	34	35	1.46	105	3.11412	7.236318	246	0.0383	0.277242	24	24	1.00	0.46
2019	110+	0.78695	1	1.27	1	1	1	1	1.27	110	3.72341	6.360883	6	0.0383	0.243702	0	0	1.00	0.27

Source: Our calculations

Fig. 10: Expanded Abridged Life Table from WHO. HLE in Czechia, males 2019.

World Health Organization (WHO) Abridged Life Table for Czechia (males in 2019), Expanded to include the Healthy Life Expectancy Calculation																		
WHO Life Table									Proportion with Disability						Sullivan Method			
Year	Age	mx	qx	lx	dx	Lx	Tx	ex	Age	mx adapt	bx	bx*Lx	k	k*bx	LxD	TxD	exD	HLYL
2019	0	0.002679	0.002673	100000	267	99759	7630233	76.30	0	0.002679	0	0	0.0406	0	99759	6730380	67.30	9.00
2019	1--4	0.000178	0.000712	99733	71	398761	7530474	75.51	1	0.000178	0.062322	24851	0.0406	0.002533	397750	6630621	66.48	9.02
2019	5--9	8.59E-05	0.00043	99662	43	498202	7131713	71.56	5	0.000436	0.130432	64981	0.0406	0.0053	495561	6232871	62.54	9.02
2019	10--14	0.000104	0.000521	99619	52	497965	6633512	66.59	10	0.000484	0.275756	137317	0.0406	0.011206	492384	5737310	57.59	9.00
2019	15-19	0.000416	0.002076	99567	207	497319	6135547	61.62	15	0.001455	1.191514	592562	0.0406	0.048418	473239	5244926	52.68	8.94
2019	20-24	0.000727	0.003629	99360	361	495900	5638228	56.75	20	0.003013	1.763767	874653	0.0406	0.071673	460357	4771687	48.02	8.72
2019	25-29	0.000725	0.003617	99000	358	494104	5142328	51.94	25	0.003628	1.52582	753913	0.0406	0.062003	463467	4311330	43.55	8.39
2019	30-34	0.00088	0.004388	98642	433	492126	4648224	47.12	30	0.004088	1.653234	813600	0.0406	0.067181	459064	3847863	39.01	8.11
2019	35-39	0.001161	0.00579	98209	569	489623	4156098	42.32	35	0.005243	1.916873	938545	0.0406	0.077894	451483	3388799	34.51	7.81
2019	40-44	0.001753	0.008727	97640	852	486071	3666475	37.55	40	0.007582	2.436024	1184080	0.0406	0.09899	437954	2937316	30.08	7.47
2019	45-49	0.003001	0.014891	96788	1441	480337	3180404	32.86	45	0.012508	3.269892	1570651	0.0406	0.132876	416512	2499362	25.82	7.04
2019	50-54	0.005314	0.026223	95347	2500	470483	2700067	28.32	50	0.021944	4.201808	1976880	0.0406	0.170745	390150	2082850	21.84	6.47
2019	55-59	0.008334	0.040819	92846	3790	454758	2229583	24.01	55	0.03563	4.636076	2108292	0.0406	0.188392	369085	1692700	18.23	5.78
2019	60-64	0.014878	0.071724	89057	6387	429314	1774826	19.93	60	0.061303	5.573372	2392728	0.0406	0.22648	332083	1323615	14.86	5.07
2019	65-69	0.023228	0.109764	82669	9074	390660	1345511	16.28	65	0.099439	5.815603	2271926	0.0406	0.236323	298338	991532	11.99	4.28
2019	70-74	0.035473	0.162916	73595	11990	338001	954850.9	12.97	70	0.152873	6.019841	2034710	0.0406	0.244623	255317	693194	9.42	3.56
2019	75-79	0.053618	0.236403	61605	14564	271617	616850.3	10.01	75	0.231801	6.241618	1695329	0.0406	0.253635	202725	437877	7.11	2.91
2019	80-84	0.088058	0.360851	47042	16975	192770	345233.3	7.34	80	0.371411	6.935786	1337013	0.0406	0.281843	138439	235152	5.00	2.34
2019	85+	0.184889	1	30067	30067	152463	152463.1	5.07	85	0.730785	8.998438	1371929	0.0406	0.365661	96713	96713	3.22	1.85

Source: Our calculations

Summary and Conclusions

Our study has produced the expanded life tables for Czechia and Hungary, providing annual life expectancy and healthy life expectancy for the Czechia and Hungary's population. The construction and application of expanded form of life tables offers great support for the health and

welfare sciences. Expanded life tables generated in the current study promote not only a better understanding of the life span and related health status, but also offer several applications for the healthy life estimation and research to improve the health and welfare professions. A main achievement was the presentation of the disability space for health state with characteristic graphs.

References

Jagger, C., Van Oyen, H., & Robine, J.-M. (2014). Health expectancy calculation by the Sullivan method: A practical guide. Newcastle upon Tyne: Institute for Ageing, Newcastle University.

Skiadas, C.H. and Skiadas, C. (2018a). The Health-Mortality Approach in Estimating the Healthy Life Years Lost Compared to the Global Burden of Disease Studies and Applications in World, USA and Japan. In Exploring the Health State of a Population by Dynamic Modeling Methods. The Springer Series on Demographic Methods and Population Analysis 45, Springer, Chum, Switzerland, pp 67-124. https://doi.org/10.1007/978-3-319-65142-2_4

Skiadas, C.H. and Skiadas, C. (2018b). Demography and Health Issues: Population Aging, Mortality and Data Analysis. The Springer Series on Demographic Methods and Population Analysis 46. Springer, Chum, Switzerland. https://doi.org/10.1007/978-3-319-76002-5

Skiadas C.H., Skiadas C. (2020a). Relation of the Weibull Shape Parameter with the Healthy Life Years Lost Estimates: Analytical Derivation and Estimation from an Extended Life Table. In: Skiadas C.H., Skiadas C. (eds) Demography of Population Health, Aging and Health Expenditures. The Springer Series on Demographic Methods and Population Analysis, vol 50. Springer, Cham. https://doi.org/10.1007/978-3-030-44695-6_2

Skiadas C.H., Skiadas C. (2020b). Direct Healthy Life Expectancy Estimates from Life Tables with a Sullivan Extension. Bridging the Gap Between HALE and Eurostat Estimates. In: Skiadas C.H., Skiadas C. (eds) Demography of Population Health, Aging and Health Expenditures. The Springer Series on Demographic Methods and Population Analysis, vol 50. Springer, Cham. https://doi.org/10.1007/978-3-030-44695-6_3

Skiadas C. H., Skiadas C. (2020c). How the unsolved problem of finding the Healthy Life Expectancy (HLE) in the far past was resolved: The case of Sweden (1751-2016) with forecasts to 2060 and comparisons with HALE. https://doi.org/10.31235/osf.io/akf8v

Sullivan, D. F. (1971). "A single index of mortality and morbidity." Health Services Mental Health Administration Health Reports 86: 347-354.

Contact

Christos H Skiadas
ManLab, Technical University of Crete, Chania, Crete, Greece

E-mail: skiadas@cmsim.net

Yiannis Dimotikalis
Hellenic Mediterranean University, Department of Management Science and Technology, Agios Nikolaos, Crete, Greece

E-mail: jdim@hmu.gr