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Mortality transition in the interwar Baltic states: findings from cross-country comparison of new life tables

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ABSTRACT
This paper is the first comparative analysis of mortality transition, as part of the demographic transition, in all the three Baltic countries during the interwar period. We address the following research questions: Which type of mortality transition is exemplified by the interwar Baltic countries' mortality patterns? Was the mortality transition completed already before WWII? What were Baltic cross-country differences in the advancement of mortality and demographic transitions? We present and use newly constructed life tables for Lithuania, 1925–1934, and draw on the work of the Estonian demographer Kalev Katus (1955–2008), publishing for the first time his life tables for Latvia in 1925–1938. Main findings: The three countries were part of the Western model of mortality transition. However, the reduction of infant and childhood mortality was lagging in Lithuania. Women of childbearing age in Estonia and mainland Latvia, as a result of earlier fertility decline, experienced longer life expectancy due to the decreased mortality from birth complications. Nevertheless, in all three countries mortality transition was still incomplete by WWII. A comparison of death causes in 1925–1939 serves to corroborate the last conclusion.

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Baltic states; life expectancy; life tables; mortality transition; demographic transition

Introduction

The history of the Nordic countries would be enriched when including the Baltics as a benchmark region for future comparisons. The Baltics complement Nordic history due to their geographic proximity as well as their multiple historical entanglements (see e.g. Kasekamp, 2018). Regarding demographic history, potentially the biggest interest for experts in Scandinavian history lies in the comparison of the course and timing of the demographic transition in the Nordic and Baltic countries. The demographic transition designates the historical shift from a Malthusian equilibrium between mortality and fertility, defined by high birth rates and high death rates, to a modern equilibrium, defined by low fertility and low death rates. Often the demographic transition is associated with an accelerating population growth, while both Malthusian and modern equilibria are described by very slow or zero natural population increase.

The demographic transition encompasses both fertility and mortality transitions. Fertility transition ends with the total fertility rate (TFR; expected number of children women would have

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during lifetime) close or below 2 (e.g. Guinnane, 2011). Mortality transition is the replacement of infectious diseases, killing mainly children, infants and childbearing mothers, by man-made and degenerative diseases as dominant death causes, closing with the life expectancy at birth approaching the 60 years mark for both genders (e.g. Omran, 1971). We focus on the mortality transition, subordinating aspects of fertility to our aim of mortality analysis.

Mortality transition in the Baltic countries is less researched than fertility transition. An important finding regarding the latter has been that Estonia and Latvia are part of Europe where fertility transition was completed during the decades between the world wars (Gortfelder & Puur, 2019; Katus, 1994). Thus, we limit our analysis to the interwar period to find out how the mortality transition was related to earlier fertility decline. More specifically, we ask what type of mortality transition, i.e. Western, accelerated or delayed, as defined by Omran (1971) describes the interwar Baltic countries? Was the mortality transition already achieved before WWII? What kind of cross-country differences in mortality and broader demographic transitions can be observed in the Baltics? The motivation for our research focus comes from mortality transition (called also 'epidemiological transition') theory (Omran, 1971, 1983, 1998; Olshansky & Ault, 1986).

A life table describes life expectancy and death probabilities in different age groups, and it is essential for answering our research questions. Until now, the aforementioned questions could be discussed using this tool only regarding Estonia (e.g. Katus, 2000; Katus, Puur, & Põldma, 2002), thanks to Kalev Katus (1955–2008) who contributed a series of life tables for 1923–1938 and 1950–2000 (Katus, 2004). Katus constructed life tables for interwar Latvia (1925–1938) but, because of his untimely death, they remained unpublished despite being used in research by himself and Vallin, Jasilionis, and Meslé (2017). We publish them as part of supplementary material of this paper (see Appendix 4).

The present paper's main contribution is the construction of life tables for Lithuania 1925–1934 (see Appendix 3). Current knowledge on changes in Lithuanian life expectancy during the 1897–1959 period is based merely on two abridged life tables of 1896–1897 (Ptukha, 1960) and 1925–1926 (Merčaitis, 1966). Hence, we offer a substantial improvement in the key facts of Lithuanian demographic history. Publishing also Katus' life tables on Latvia (tables on Estonia are available on the internet) we compile and expand all available knowledge on life expectancy in the interwar Baltic countries, facilitating further historical demographic research in this area.

Despite the Baltic countries exemplify the Western mortality transition model, Estonia and Latvia were more advanced in this transition, although still incomplete by WWII. We corroborate this claim by comparing causes of death in all three countries, using newly published historical statistics (Norkus, Ambrulevičiūtė, Markevičiūtė, Morkevičius, & Žvaliauskas, 2022a, 2022b, 2022c). This is our second original contribution.

In the following, we start with an inventory of available life tables in the first section. This presents a few attempts since the very beginning of application of this method in the nineteenth century, but focuses on the contributions of Katus that are more relevant for our period. The display of our own contribution starts in the second section. We present our sources of primary information on Lithuania, i.e. the distribution of population and mortality by age for 1925–1934. We explain how these data were processed to constructing life tables, when both the data and life tables are presented in the appendices. In the third, explanatory section we interpret and explain our key findings. The concluding section summarises our main findings from cross-country comparisons of life tables, and supplements them with comparisons using the newly published data on death causes.

Research on life expectancy in the Baltic countries: state of the art

The first life tables on Baltic countries were constructed by Besser and Ballod (1897), covering the Baltic provinces Estland, Livland and Kurland of the Russian empire (see Figure 1). They were based on data from a regional census held in 1881. According to this, life expectancy at birth (e°_0) in 1880–1883 was 39.13 years for men and 42.71 for women. This was much higher than

Figure 1. Boundaries of Tsarist Russia provinces (1897) and contemporary borders of the Baltic States. Dotted lines denote administrative delimitations between provinces (governorates) of the Russian empire; dash line denotes the border between the Russian and German empires; solid lines denote contemporary state borders. Own production, credits to Vaidas Morkevičius for assistance.

what was found for 50 other European provinces of the Russian empire in 1896–1897, i.e. 31.32 and 33.41 years respectively (Novosel'skij, 1916, p. 120, 125), and not much less than in France for 1882–1886, with 41.6 for men and 44.4 for women. It was slightly above Prussian figures of 37.59 for males and 40.70 for females and significantly above Bavaria, which recorded 34.87 for males and 37.9 for females in 1881–1890 (Besser & Ballod, 1897, pp. 107–124).

The figures of Besser and Ballods refer to the three Baltic provinces as one entity. Hence, their data do not allow differentiating between the Baltic countries as they are known today. Moreover, 26% of the Latvian population lived in the Western part of the Vitebsk province, Latgale, which did not belong to the historical Baltic provinces. It had been under the Polish-Lithuanian rule since the sixteenth century and was annexed by Russia in 1772, while Estland and Livland came under Russian suzerainty in 1721. The Kurland province shared common fate with Lithuania in 1795. Latgale did differ from mainland Latvia culturally as its Latvian population was Catholic, differently from the Protestant Lutheran Baltic provinces. It was also different economically, displaying lower productivity, and inferior standard of living (Norkus, Morkevičius, Ambrulevičiūtė, & Markevičiūtė, 2022).

Historical changes in borders and administrative delimitations also complicate the interpretation of life expectancy estimates based on the All-Russian population census in 1897. Researchers interested in regional differences in life expectancy in the Russian empire around the turn of the nineteenth century use abridged life tables for 1896–1897 by the Ukrainian demographer Ptukha (1960, p. 261), which are based on the 1897 census.[1]

Ptukha's estimates include for the first time Lithuanians, whose life expectancy at birth was 41.12 for men and 42.40 years for women. Also, for the first time, these data distinguish inhabitants of the Baltic provinces, providing life expectancy values for Estonians (males 41.61 and females 44.58 years) and Latvians (respectively 43.07 and 46.01). However, Ptukha was not interested in the life expectancy of particular territories, but in its variation among the ethnic groups or 'nationalities' of the Russian empire, including Russians, Ukrainians, Belarusians, Moldovans, Jews, Tatars, Bashkirs, and Chuvashs. According to Ptukha's findings, the Baltic nations had the longest life expectancy, while Russians had the shortest, with 27.49 years for males and 29.82 for females.

During the interwar independence period (1918–1940), two population censuses were held in Estonia, in 1922 and 1934. Using the data from the 1934 census, the Estonian statistical office constructed life tables for 1932–1934 (Reiman, 1936; Riigi Statistika Keskbüroo, 1937). According to Riigi Statistika Keskbüroo (1937, pp. 38–39), life expectancy in 1932–1934 was 53.12 years for men and 59.60 years for women. Interwar Latvia held four censuses, in 1920, 1925, 1930, and 1935, with findings of the first census remaining partially unpublished. Based on data from the 1930 census, the Latvian statistical office published life tables for 1929–1932 (Valsts statistiskā pārvalde, 1936). They used the 1935 population census for the production of life tables for 1934–1936 (Valsts statistiskā pārvalde, 1938). According to these estimates, life expectancy at birth in Latvia increased from 54.56 years for males and 60.10 years for females in 1929–1932–55.59 years for males and 60.93 years for females in 1934–1936.

In interwar Lithuania, only one population census was held, in 1923, but no life tables were published. By 2022, the only available life tables for interwar Lithuania are abridged life tables for 1925–1926, constructed by Merčaitis (1966). They are based on the 1923 population census and 1925–1926 mortality data. According to his doctoral thesis, life expectancy at birth in 1925–1926 was 48.58 years for males, 51.89 for females, and 50.25 for both genders.

The research on life expectancy in interwar Estonia and Latvia came to a real breakthrough thanks to Katus (1955–2008), who constructed abridged life tables for Estonia (1923–1938) and Latvia (1925–1938). Tables 1–4 provide a summary of this work, recently introduced by Vallin et al. (2017) in less detail as only life expectancy values at birth are presented. Katus published life tables for Estonia as part of a larger project, including life tables for the 1950–2000 period. In this paper, we present his life expectancy estimates for interwar Latvia, which go beyond the abovementioned

[1]Ptukha (1924) provides early version of these life tables, republished in 1960.

estimates by the Latvian national statistical office. Katus' tables for Latvia have previously never been published and were provided by a research team of the former collaborative project on Health crisis in the Baltic countries coordinated by the French National Demographic Research Institute (INED). The tables of supplementary material are found in Appendix 4.

Life tables published by the Estonian statistical office in 1937 for 1932–1934 are in 3×1 format, while tables by Katus are 1×5. Hence, they are not comparable without recalculation. However, the mean value of Katus' figures of life expectancy at birth for females in 1932–1934 (see Table 1) is very close (59.73 years) to the finding of interwar statisticians (59.60 years). The estimates of life expectancy at age one are nearly identical (63.84 and 63.87). This indicates high reliability of both estimates.

The same applies to estimates of male life expectancy (see Table 2), as the mean of Katus' annual estimates of life expectancy at birth for 1932–1934 is 53.20 years, while national statistical office provides 53.12 years. Life expectancy at one year of age was 57.81 and 57.93 years correspondingly.

Assessing the reliability of available life expectancy estimates for Latvia, we can compare the means of Katus' for 1929–1932 and 1934–1936 from his 1×5 format tables with Latvia's national office figures in the 4×1 and 3×1 tables for these years (Table 3). For 1929–1936 we get less closer figures than in Estonia's case: the mean of Katus' figures for females at birth is 59.82 years, while Latvian statistical office did provide 60.10 years. For female infants at 1 year age, the figures are 64.31 and 64.50. The difference may be attributed to larger (four years) interval, used by Latvian statistical office, because for 1934–1936 (three years) the means of Katus' estimates are closer to its figures. The Latvian statistical office provides 60.93 years at birth and 64.79 years at one year age. The means of Katus' values for these three years are 60.93 (!) and 65.06 correspondingly.

We find the same pattern in the relationship between Katus' estimates (see Table 4) to the Latvian statistical office estimates for males. The office provides for 1929–1932 54.56 years at birth and 59.45 years at one year age. The means of Katus' annual values are 54.11 and 59.20. For 1934–1936, the national statistical office figures are 55.59 and 60.10, and the means of Katus' annual values 55.35 and 60.12 (!).

Tables 5 and 6 provide our key results from the life Tables A10–A19 for Lithuania in Appendix 3, complementary to estimates by Katus in Tables 1–4. They allow comparisons of life expectancy in all the three Baltic states at age groups. While strong annual fluctuations in interwar mortality pushed the statistical offices of the Baltic states to use three- or four-year averages of mortality instead of annual values, we have been able to construct annual data. In the next section, we describe how our life tables for Lithuania were constructed.

New life tables for Lithuania, 1925–1934: filling out the gap in the life expectancy data

Starting in 1925, the Lithuanian statistical office published death numbers by age groups. In 1925–1927 the age categories included infants, 0–12 months, children, 1–4 years, and 5-year groups between ages 5 and 29, and beyond that 10-year groups up to the 80+ category. In 1928 this distribution was refined, providing data by 5-year groups between ages 5 and 100. Because of the lack of age-specific mortality data for 1923–1924, Merčaitis constructed life tables for the years 1925–1926 using the age structure of the 1923 census, assuming the age distribution remained unchanged.

For some reason, it remained unnoticed that the Lithuanian statistical office had population age distribution data also for later years. The last time such data were published were for 1932 in the general annual statistical survey (Centralinis Statistikos Biuras, 1933, p. 10). Besides that, mortality and population distribution data for 1928–1934 were published in the annual surveys of public health by the Health Department of the Lithuanian Ministry of Internal Affairs (Sveikatos departamentas, 1928, p. 7, 10; 1929, p. 7, 10; 1930, p. 7, 10; 1933, p. 9, 12; 1934, p. 9, 12; 1936, p. 7, 10). So

Table 1. Estonian females, life expectancy at birth 1923–1938.

Age	1923	1924	1925	1926	1927	1928	1929	1930	1931	1932	1933	1934	1935	1936	1937	1938
0	56.54	57.48	58.24	55.47	53.12	56.04	54.84	57.78	56.98	58.60	59.77	60.83	59.88	60.01	60.64	61.94
1	61.45	61.83	62.46	60.03	57.62	60.25	59.29	62.09	61.61	63.15	63.91	64.45	63.51	63.67	64.66	65.22
5	61.16	60.81	61.09	59.67	58.04	59.83	58.40	61.18	60.33	61.58	62.01	62.56	61.74	61.69	62.74	62.88
10	57.22	56.78	56.98	56.34	55.28	56.17	54.58	57.53	56.50	57.59	57.97	58.60	57.91	57.52	58.68	58.65
15	53.03	52.63	52.86	52.26	51.43	52.08	50.47	53.39	52.09	53.44	53.65	54.37	53.76	53.26	54.30	54.29
20	49.15	48.69	48.99	48.35	47.59	48.20	46.71	49.37	48.18	49.41	49.53	50.29	49.72	49.17	50.22	50.10
25	45.21	44.85	45.18	44.53	43.91	44.60	43.05	45.57	44.41	45.52	45.65	46.30	45.68	45.07	46.22	46.08
30	41,35	40,93	41,23	40,75	40,08	40,82	39,25	41,67	40.51	41,61	41,60	42,32	41,73	41,01	42,00	41,95
35	37.22	36.80	37.09	36.51	36.00	36.80	35.04	37.44	36.38	37.46	37.38	38.13	37.53	36.85	37.75	37.65
40	33.24	32.79	33.08	32.40	32.09	33.00	31.02	33.41	32.48	33.52	33.33	34.13	33.50	32.83	33.64	33.47
45	29.04	28.57	28.76	28.25	27.99	28.75	26.91	29.24	28.26	29.30	29.09	29.87	29.28	28.65	29.41	29.24
50	24.93	24.43	24.52	24.23	24.06	24.65	23.00	25.24	24.18	25.19	24.95	25.69	25.15	24.59	25.29	25.15
55	21.02	20.48	20.50	20.21	20.05	20.63	19.04	21.25	20.19	21.25	21.01	21.66	21.15	20.62	21.28	21.06
60	17.27	16.76	16.76	16.45	16.30	16.82	15.23	17.39	16.31	17.42	17.20	17.77	17.29	16.85	17.47	17.17
65	13.68	13.17	13.24	12.94	12.85	13.45	11.96	13.96	13.04	13.97	13.77	14.25	13.65	13.21	13.88	13.59
70	10.58	10.07	10.19	9.83	9.78	10.38	8.87	10.72	10.01	10.75	10.67	11.19	10.45	9.98	10.75	10.37
75	7.92	7.42	7.52	7.15	7.22	7.74	6.42	8.03	7.40	8.06	7.84	8.36	7.75	7.36	8.07	7.77
80	6.30	5.70	5.69	5.23	5.46	5.86	4.77	6.22	5.62	6.21	5.74	6.30	5.70	5.22	5.82	5.36
85	4.53	3.97	4.04	3.79	4.25	4.64	3.56	4.70	4.11	4.56	3.91	4.36	3.87	3.51	4.12	3.65

Source: Katus (2004).

Table 2. Estonian males, life expectancy at birth 1923–1938.

	1923	1924	1925	1926	1927	1928	1929	1930	1931	1932	1933	1934	1935	1936	1937	1938
0	49.94	50.59	51.28	49.34	46.93	49.79	48.22	51.53	50.82	52.65	53.40	53.54	53.15	53.11	54.30	55.45
1	55.37	55.59	56.02	54.27	52.00	54.78	53.06	56.43	55.57	57.28	57.89	58.26	57.83	57.73	58.78	59.37
5	54.89	54.30	54.67	53.83	52.13	54.12	52.23	55.08	54.09	55.72	55.94	56.49	56.15	55.80	56.44	57.00
10	50.91	50.25	50.55	50.47	49.03	50.31	48.41	51.23	50.24	51.64	51.81	52.35	52.18	51.63	52.28	52.75
15	46.58	45.93	46.17	46.13	44.89	46.16	44.18	47.00	45.91	47.27	47.50	48.14	47.78	47.12	47.99	48.32
20	42.60	42.01	42.13	42.04	40.94	42.12	40.10	43.12	41.91	43.38	43.39	44.08	43.46	42.99	43.87	44.12
25	39.05	38.69	38.67	38.43	37.64	38.69	36.58	39.40	38.31	39.65	39.46	40.31	39.66	39.24	39.99	40.18
30	35.51	35.01	34.87	34.95	34.10	34.94	33.05	35.63	34.72	35.88	35.66	36.37	35.71	35.44	36.08	36.19
35	31.53	31.22	31.01	30.99	30.31	30.98	29.13	31.57	30.69	31.77	1923	32.21	31.59	31.32	31.95	32.07
40	27.83	27.71	27.44	27.29	26.84	27.32	25.62	27.89	27.10	28.09	28.00	28.44	27.89	27.59	28.16	28.28
45	24.29	24.21	23.90	23.61	23.25	23.73	22.15	24.28	23.43	24.40	24.35	24.74	24.24	23.95	24.45	24.56
50	20.72	20.72	20.38	19.97	19.74	20.22	18.77	20.73	19.80	20.76	20.71	21.02	20.59	20.31	20.74	20.92
55	17.51	17.36	17.14	16.67	16.52	16.96	15.60	17.55	16.68	17.48	17.47	17.75	17.31	17.01	17.40	17.55
60	14.43	14.26	14.33	13.76	13.66	13.97	12.56	14.47	13.60	14.25	14.29	14.60	14.18	13.87	14.23	14.36
65	11.46	11.31	11.48	10.87	10.90	11.22	10.08	11.83	11.04	11.55	11.48	11.73	11.27	10.96	11.33	11.44
70	9.07	8.90	9.17	8.36	8.49	8.71	7.70	9.28	8.59	9.01	8.96	9.40	9.02	8.66	9.03	8.96
75	6.97	6.83	7.03	6.33	6.51	6.62	5.79	7.13	6.47	6.81	6.71	7.25	6.86	6.54	7.00	6.98
80	5.48	5.38	5.30	4.65	4.87	4.77	4.20	5.43	4.74	5.08	4.89	5.73	5.16	4.67	5.19	4.95
85	4.50	4.26	4.12	3.58	3.76	3.73	3.16	4.02	3.31	3.52	3.36	4.32	3.97	3.59	4.04	3.83

Source: Katus, 2004.

Table 3. Latvian females, life expectancy at birth 1925–1938.

Age	1925	1926	1927	1928	1929	1930	1931	1932	1933	1934	1935	1936	1937	1938
0	56.01	58.13	56.81	58.78	58.08	59.47	60.70	61.03	61.56	60.08	61.20	61.51	61.30	62.71
1	61.06	62.30	61.43	63.38	63.10	63.91	64.76	65.45	65.15	64.58	64.60	65.30	65.33	66.05
5	61.32	61.41	60.92	62.26	61.69	62.17	62.71	63.50	63.19	63.17	62.57	63.05	62.97	63.67
10	57.53	57.41	56.92	58.07	57.46	58.07	58.45	59.19	58.99	59.04	58.51	58.85	58.66	59.57
15	53.38	53.10	52.66	53.68	53.10	53.73	54.05	54.68	54.55	54.76	54.10	54.45	54.27	55.22
20	49.34	49.05	48.74	49.58	48.90	49.57	49.83	50.59	50.28	50.58	49.92	50.20	50.02	51.02
25	45.50	45.22	44.92	45.63	44.92	45.63	45.89	46.56	46.22	46.54	45.85	46.20	45.98	46.96
30	41.64	41.37	41.01	41.62	40.92	41.60	41.88	42.49	42.21	42.52	41.76	42.06	41.89	42.81
35	37.73	37.33	37.03	37.64	36.94	37.53	37.91	38.44	38.11	38.47	37.69	37.91	37.74	38.61
40	33.72	33.27	32.88	33.53	32.86	33.46	33.77	34.32	34.02	34.33	33.62	33.80	33.63	34.38
45	29.68	29.19	28.79	29.53	28.78	29.36	29.57	30.12	29.84	30.18	29.45	29.60	29.52	30.14
50	25.62	25.20	24.79	25.42	24.75	25.37	25.47	25.85	25.72	26.05	25.33	25.44	25.40	26.05
55	21.73	21.38	20.85	21.52	20.86	21.42	21.47	21.83	21.75	22.05	21.30	21.49	21.36	22.00
60	18.01	17.64	17.08	17.74	17.18	17.64	17.64	18.06	17.97	18.14	17.43	17.75	17.53	18.12
65	14.60	14.24	13.71	14.23	13.62	14.12	14.19	14.61	14.33	14.50	13.88	14.23	13.96	14.58
70	11.53	11.08	10.58	10.98	10.46	10.85	11.02	11.40	11.22	11.29	10.76	11.02	10.84	11.38
75	8.98	8.51	8.18	8.45	8.05	8.44	8.37	8.71	8.51	8.65	8.09	8.41	8.18	8.66
80	6.95	6.42	6.14	6.32	5.86	6.38	6.36	6.71	6.47	6.63	6.05	6.24	6.11	6.43
85	5.61	5.22	5.12	5.30	4.58	4.90	4.93	5.14	5.22	5.17	4.65	4.81	4.59	4.91
90	4.95	4.18	4.08	3.84	3.42	4.02	4.12	4.28	4.04	3.85	3.59	3.82	3.65	4.10
95	4.40	3.31	3.72	3.19	3.26	3.26	3.26	3.23	3.27	3.24	3.21	3.24	3.21	3.22
100	3.95	2.69	3.22	2.56	2.77	2.70	2.69	2.59	2.65	2.63	2.71	2.71	2.72	2.65

Source: Katus (2008). Previously unpublished, used in Vallin et al. (2017), see Appendix 4.

Table 4. Latvian males, life expectancy at birth 1925–1938.

Age	1925	1926	1927	1928	1929	1930	1931	1932	1933	1934	1935	1936	1937	1938
0	50.36	52.13	51.08	52.97	52.44	53.77	55.00	55.24	56.15	54.70	55.70	55.67	55.77	56.87
1	56.18	56.74	56.25	58.20	58.06	58.83	59.57	60.34	60.17	59.81	60.22	60.34	60.66	60.80
5	56.45	56.17	55.75	57.11	56.54	57.11	57.41	58.27	58.27	58.44	58.33	58.14	58.46	58.50
10	52.57	52.30	51.93	52.93	52.27	52.94	53.15	53.94	53.98	54.34	54.09	53.94	54.25	54.31
15	48.38	47.97	47.73	48.58	47.85	48.59	48.73	49.42	49.56	50.03	49.66	49.46	49.81	49.94
20	44.29	43.85	43.65	44.31	43.71	44.52	44.59	45.36	45.40	45.81	45.46	45.27	45.49	45.82
25	40.70	40.16	39.96	40.52	39.97	40.67	40.67	41.47	41.44	41.82	41.42	41.30	41.56	41.87
30	37.07	36.38	36.16	36.58	36.03	36.78	36.64	37.47	37.47	37.72	37.31	37.23	37.46	37.76
35	33.19	32.44	32.25	32.70	31.97	32.86	32.61	33.47	33.35	33.67	33.17	33.06	33.28	33.57
40	29.21	28.57	28.49	28.78	28.14	28.80	28.69	29.44	29.21	29.62	29.18	28.99	29.23	29.50
45	25.32	24.76	24.70	24.84	24.38	24.93	24.85	25.51	25.23	25.60	25.15	25.09	25.24	25.49
50	21.74	21.06	21.03	21.06	20.76	21.21	21.13	21.58	21.43	21.77	21.31	21.28	21.40	21.70
55	18.34	17.63	17.64	17.68	17.37	17.74	17.66	18.07	17.98	18.22	17.80	17.78	17.74	18.18
60	15.17	14.37	14.45	14.56	14.12	14.58	14.53	14.70	14.76	14.82	14.56	14.60	14.47	14.96
65	12.39	11.52	11.71	11.80	11.32	11.92	11.76	11.91	11.93	12.00	11.59	11.67	11.62	12.09
70	9.74	9.08	9.16	9.21	8.82	9.36	9.23	9.27	9.27	9.52	9.04	9.19	9.05	9.50
75	7.50	7.02	7.05	7.12	6.69	7.26	6.91	7.08	7.23	7.28	6.86	6.98	6.97	7.55
80	5.86	5.36	5.27	5.46	4.83	5.44	5.30	5.37	5.42	5.57	5.12	5.24	5.21	5.85
85	4.45	4.07	4.38	4.44	3.85	4.33	4.33	4.10	4.24	4.12	3.73	3.83	3.84	4.42
90	3.50	3.70	3.59	3.71	3.00	2.95	3.59	3.26	3.53	3.24	2.97	2.74	3.07	3.14
95	1.93	3.53	3.46	2.96	2.77	1.95	2.22	2.20	2.33	1.97	2.27	1.95	2.25	2.39
100	0.56	3.21	3.07	2.45	2.38	0.62	1.61	1.77	1.86	0.61	1.78	1.14	1.90	1.96

Source: Katus (2008). Previously unpublished, used in Vallin et al. (2017), see Appendix 4.

Table 5. The life expectancy of Lithuanian females in 1925–1934, see Appendix 3.

Age	1925	1926	1927	1928	1929	1930	1931	1932	1933	1934
0	47.96	51.71	48.96	51.87	50.28	51.75	52.63	52.31	56.09	53.15
1	57.92	59.76	57.12	60.66	59.76	60.04	60.32	61.46	62.20	61.59
5	58.73	59.05	56.83	60.63	59.61	59.96	59.52	60.65	60.80	60.77
10	55.19	55.18	53.11	56.97	55.96	56.64	55.96	56.96	56.98	57.14
15	50.89	50.80	48.55	52.43	51.34	52.06	51.38	52.45	52.48	52.66
20	46.66	46.44	44.26	48.07	46.94	47.64	46.95	47.93	47.91	48.07
25	42.56	42.20	40.13	43.89	42.71	43.43	42.74	43.66	43.57	43.78
30	38.57	38.14	36.19	39.94	38.78	39.45	38.68	39.52	39.42	39.68
35	34.80	34.34	32.55	36.16	34.95	35.71	34.95	35.76	35.55	35.88
40	31.16	30.67	29.05	32.19	31.07	31.89	31.20	31.89	31.80	32.09
45	27.65	27.14	25.68	28.19	27.11	27.96	27.15	27.87	27.75	28.06
50	24.29	23.77	22.48	24.26	23.13	23.85	23.14	23.93	23.63	24.09
55	21.09	20.58	19.46	21.06	20.02	20.70	20.03	20.74	20.45	20.90
60	18.06	17.56	16.61	18.01	17.08	17.72	17.10	17.72	17.45	17.88
65	15.17	14.72	13.95	15.13	14.32	14.89	14.34	14.86	14.63	15.01
70	12.40	12.02	11.44	12.37	11.72	12.19	11.73	12.15	11.96	12.28
75	9.69	9.42	9.03	9.68	9.21	9.56	9.22	9.51	9.39	9.61
80	6.88	6.78	6.58	6.92	6.67	6.86	6.68	6.83	6.80	6.88
85	3.68	3.78	3.78	3.78	3.78	3.78	3.78	3.78	3.88	3.78

Table 6. The life expectancy of Lithuanian males in 1925–1934, see Appendix 3.

Age	1925	1926	1927	1928	1929	1930	1931	1932	1933	1934
0	45.38	48.31	45.80	49.48	46.76	48.54	49.26	49.09	53.00	50.53
1	56.64	57.92	55.49	59.11	57.49	58.31	58.23	59.87	60.63	60.20
5	57.87	57.70	55.60	59.12	57.59	58.45	57.67	59.16	59.36	59.54
10	54.42	54.00	52.04	55.40	54.10	55.27	54.14	55.37	55.53	55.90
15	50.05	49.56	47.40	50.81	49.51	50.68	49.58	50.83	51.00	51.37
20	45.84	45.30	43.13	46.41	45.16	46.28	45.14	46.33	46.44	46.82
25	41.78	41.21	39.05	42.29	41.10	42.13	41.01	42.17	42.28	42.54
30	37.73	37.19	35.15	38.28	37.15	38.17	37.05	38.16	38.16	38.35
35	33.80	33.31	31.41	34.21	33.21	34.37	33.33	34.30	34.19	34.47
40	30.02	29.57	27.82	30.31	29.31	30.39	29.39	30.48	30.33	30.67
45	26.41	26.00	24.41	26.43	25.47	26.51	25.68	26.67	26.59	26.82
50	22.99	22.61	21.19	22.60	21.62	22.56	21.72	22.69	22.64	22.88
55	19.77	19.42	18.19	19.41	18.55	19.44	18.70	19.58	19.48	19.72
60	16.76	16.45	15.40	16.44	15.69	16.51	15.88	16.66	16.53	16.76
65	13.97	13.69	12.83	13.68	13.05	13.79	13.26	13.93	13.78	13.99
70	11.35	11.12	10.46	11.12	10.62	11.23	10.82	11.36	11.22	11.39
75	8.86	8.70	8.24	8.69	8.34	8.79	8.51	8.90	8.78	8.91
80	6.36	6.27	6.03	6.27	6.08	6.33	6.18	6.39	6.34	6.41
85	3.50	3.50	3.50	3.50	3.50	3.50	3.50	3.50	3.56	3.56

this publication contains data on population distribution by age also for 1933 and 1934, which are missing in the data published by the Lithuanian statistical office.[2]

Neither Lithuanian annual statistical surveys nor public health surveys provide information how population distribution by age was calculated. One can guess that the shares of the population established by the 1923 census were used as benchmarks. However, there is no exact correspondence between the published figures and those which can be derived from population and subpopulation (males and females) totals, applying to them the exact shares of age categories established by the 1923 census. Thus, most probably more sophisticated estimation procedure was applied, which we are unable to reconstruct. Nevertheless, the available estimates are authentic historical statistics, and they are sufficient to construct life tables covering the period of 1925–1934, providing a basis for cross-country comparisons of life expectancy in the Baltic countries.

[2]Norkus (2017) provides life tables for 1932 for both genders. However, in these tables end of the year populations were used, differently from the present tables with midyear population.

To adjust for missing age distribution of the population in 1925–1927, we follow Merčaitis and assume the same distribution as in the 1923 census. This enhances the comparability of our and his findings for 1925–1926. However, while Merčaitis life tables use the average of 1925–1926 mortality for 01.01.1926, we use annual mortality data and mid-year population. To make our results more comparable with Katus' estimates for the other Baltic countries, we also use a 5×1 abridged life table format. Tables A1–A6 in Appendix 1 present the data on distribution of Lithuania's population by age and gender in 1925–1935. Tables A7–A9 in Appendix 2 contain mortality data distributed by age and gender. Tables A10–A19 in Appendix 3 contain our calculated life tables by gender.

Merčaitis used a life table construction method developed in the 1920s by Paevskij (1970, pp. 17–46). We use the life table template by the UK Office for National Statistics, which is based on abridged life table developed by Chiang (1979).[3] To obtain age-specific death rates M_x up to the last open-ended interval 85+ and adjust for possible age-reporting problems at old ages, we apply the Gompertz-Makeham modelling (Vallin & Berlinguer, 2006). The model has three parameters: R is baseline mortality, α is the rate of mortality increase with age x, and A is an 'exogenous' parameter that is independent of age of dying. We calculate mortality rates according to the following equation:

$$M_x = A + R \cdot e^{\alpha \bar{x}} \tag{1}$$

where $\bar{x}$ – is the mean age at death within an elementary age interval. For all ages except the last open-ended interval, we assume the mean age to be equal to the middle of the age interval, e.g. 27.5 years for the 25–29 interval. The R and α parameters are estimated using observed death rates for the age range 35–49 and by using ordinary least squares (OLS) regression:

$$\ln(M_x) = \ln R + \alpha \cdot \bar{x} \tag{2}$$

The last parameter, A, in Equation (1), refers to the average of age-specific residuals of the OLS regression:

$A = \frac{1}{N}\sum_x (M_x - R \cdot e^{\alpha \cdot \bar{x}})$, where N is the number of age groups. The obtained parameters allow us to estimate death rates for each five-year age interval and correct death rates above the age of 50.

Differences in methods may account discrepancies between our and previously published estimates. To recall, according to Merčaitis, life expectancy at birth in 1925–1926 was 48.58 years for males 51.89 for females. According to our findings, life expectancy at birth in 1925 was substantially lower – 45.58 for males, 47.96 for females. We argue that our estimates are more realistic since mortality data used by Merčaitis are not adjusted for under-registration of infant deaths and most likely underestimate old age mortality. Similar problems may also have influenced previously published estimates by Katus (2008). Vallin et al. (2017, p. 196) proposed a correction factor for under-registration of infant deaths for the period since early 1950s to early 1990s. We take a conservative approach assuming that the undercount of infant deaths in Lithuania in 1925–1934 was similar to that of the 1950s, i.e. 9%.

As the official population estimates did not completely account for international migration, further refinement is needed to obtain more precise population denominators, which are necessary to compute death rates. With no noticeable immigration to Lithuania, the total emigration during 1925–1934 was 70 886 persons, which is 23.03% of the natural population increase (Vaskela, 2022). Emigration did not affect all age groups equally, as most emigrants were young males. Most probably, corrected life expectancy figures should be slightly lower than our estimates. However, we leave these refinements for further research, which needs more detailed data on the distribution of emigrants by age.

[3]https://www.ons.gov.uk/ons/rel/subnational-health4/life-expec-at-birth-age-65/2004-06-to-2008-10/ref-life-table-template.xls

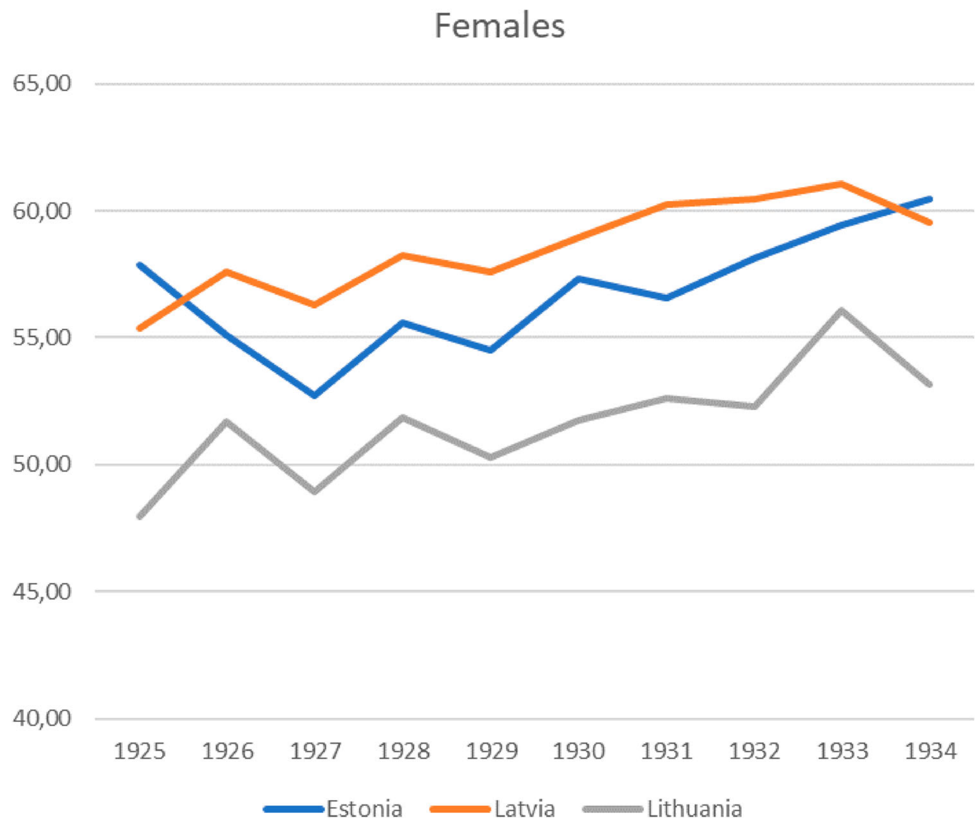

Figure 2. Female life expectancy at birth in Estonia, Latvia and Lithuania in 1925–1934. Sources: Katus, 2004; 2008 (see Appendix 4); own estimates. See also: Vallin et al., 2017, p. 196.

In the period 1925–1934, Latvia was the best performing Baltic state in terms of life expectancy at birth. However, in 1925 Latvian male and female life expectancy was slightly below the Estonian level. This could be due to Latvia's greater destruction, including the dislocation of its population during WWI, which made recovery to the pre-war economic level more difficult (Norkus & Markevičiūtė, 2021). By 1934, life expectancy of Latvian males surpassed that of their Estonian peers by 1.42 years. However, the edge of Latvian females over their Estonian peers was less (see Figure 2) and vanished in 1934, re-emerging in 1935–1938 (cp. Tables 1 and 3).

Lithuania remained the worst performing country during the entire period. Assuming Katus and Puur (1991, p. 2540) estimates for Estonia in 1897 and Ptukha's (1960, p. 261) for Lithuania in 1896–1897, Lithuania's lag behind Estonia increased from 0.75 to 5.9 years for males and from 3.3 to 10.28 years for females by 1925. Then these differences did decrease to 3.01 years for males and 7.68 years for females in 1934. In 1928 and in 1933 life expectancy of Lithuanian men was nearly at the Estonian level. However, the life expectancy gap between Estonian and Lithuanian women was never lower than 3.68 years, as in 1933. Figures 2 and 3 display differences in life expectancy at birth in three Baltic countries.

Uneven advancement of epidemiological transition in interwar Baltics

What do new data on mortality indicate about the timing and speed of the mortality transition in Lithuania, compared with the other Baltic countries? Epidemiological transition involves a change in the structure of morbidity and causes of mortality (Omran, 1971, 1983, 1998; Olshansky & Ault,

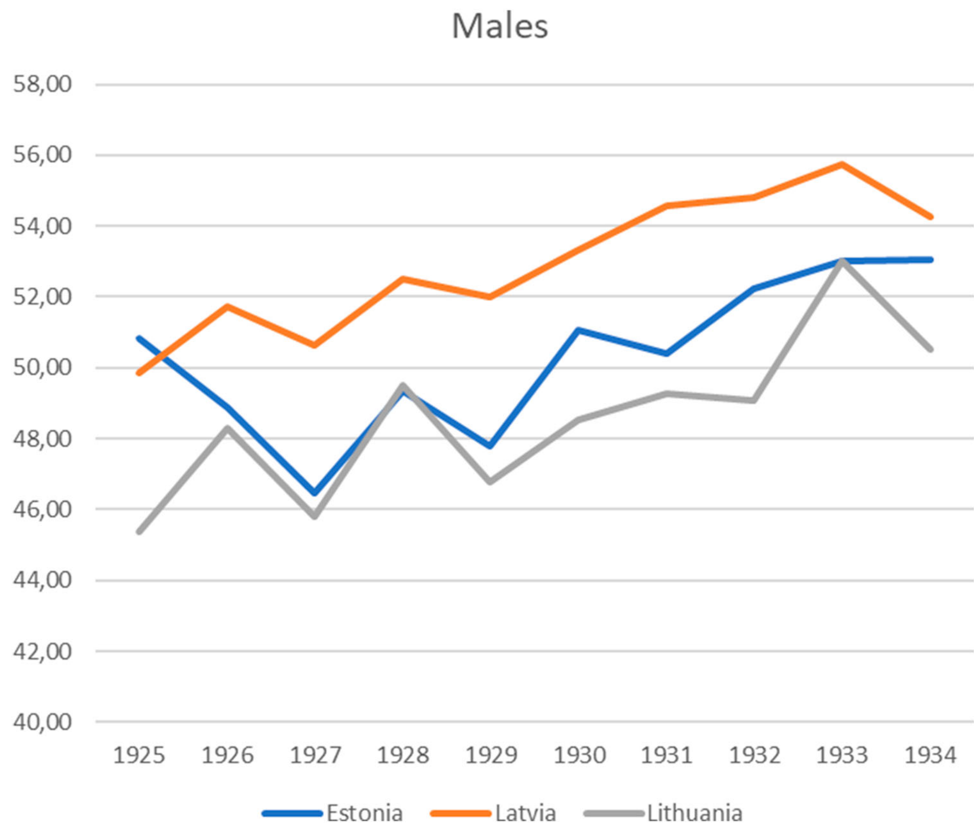

Figure 3. Male life expectancy at birth in Estonia, Latvia and Lithuania in 1925–1934. Sources: Katus, 2004; 2008 (see Appendix 4); own estimates. See also: Vallin et al., 2017, p. 196.

1986). In Russia proper, the epidemiological transition had barely began by 1897, as indicated by its very low life expectancy of 27.49 and 29.82 years for ethnic Russian men and women respectively (Ptukha, 1960, p. 261). At this time the epidemiological transition (the stage of receding pandemics) was clearly underway in the Baltic countries. This indicates that these countries represent a classical or Western model of epidemiological transition, where mortality started to decrease since the late eighteenth century due to early success in the control of epidemics, improvement of nutrition, and public hygiene (Fogel, 2004; McKeown, 1988; Omran, 1971).

The epidemiological transition in Russia, when life expectancy increased from around 28 to 60 for males and from 30 to 70 for females during 1897–1960, is considered extremely fast. There is also a third model, i.e. – a delayed epidemiological transition–model, which is exemplified by the countries mainly in Africa, Latin America, and South Africa, where infectious diseases killing children and bearing mothers were put under control only after World War II. However, this model was not accompanied by birth rate decrease, improvement in nutrition and standard of living.

An interesting feature of the Baltic countries is a very uneven pace of the epidemiological transition, shown by life expectancy figures. While female life expectancy approached 60 already by 1935 in Estonia and Latvia, it remained closer to 50 in Lithuania. Significantly higher life expectancy at the end of the first life year compared with life expectancy at birth indicates the incompleteness of mortality transition in all three countries. In Estonia and Latvia, the difference between life expectancy at birth and at age one amounted to 4–5 years. In Lithuania, it sometimes exceeded 10 years which indicates much higher levels of infant mortality in Lithuania. This is corroborated by infant mortality data in Table 7 which also covers 1935–1939, the period for which we have insufficient

Table 7. Infant mortality in the Baltic countries, 1920–1939 (promilles).

	Estonia			Latvia			Lithuania		
	Boys ‰	Girls ‰	Total ‰	Boys ‰	Girls ‰	Total ‰	Boys ‰	Girls ‰	Total ‰
1920	ND	ND	ND	141.1	114.8	128.4	ND	ND	ND
1921	ND	ND	ND	100.2	85.4	93.2	ND	ND	ND
1922	138.6	119.1	129.2	98.3	82.5	90.8	ND	ND	ND
1923	119.5	97.7	108.9	94.4	81.9	88.4	ND	ND	ND
1924	111.8	87.3	99.9	111.4	89.8	100.8	ND	ND	ND
1925	104.2	86.5	95.7	118.0	95.8	107.2	192.1	165.2	179.0
1926	110.1	93.0	101.8	96.0	79.4	87.9	160.0	131.3	146.0
1927	125.1	103.4	114.6	103.6	87.1	95.7	164.5	136.6	151.0
1928	116.4	90.3	103.6	106.0	86.2	96.3	155.3	138.8	147.3
1929	121.0	99.5	110.5	115.7	97.2	106.7	189.0	162.3	176.1
1930	109.3	90.3	100.1	96.9	82.9	90.0	168.8	139.3	154.4
1931	109.4	96.0	102.8	92.2	79.9	86.3	158.2	131.9	145.4
1932	102.6	90.7	96.8	97.9	80.1	89.3	182.2	150.4	166.7
1933	100.8	86.7	94.0	82.7	69.6	76.4	135.0	106.7	121.3
1934	103.9	77.3	91.1	103.6	86.1	95.1	178.4	151.8	165.5
1935	101.3	76.4	89.3	89.8	67.2	78.9	134.9	110.9	123.3
1936	102.3	75.6	89.2	88.7	71.0	80.1	140.6	115.3	128.3
1937	99.2	81.7	90.7	94.4	75.2	85.0	134.3	106.2	120.5
1938	85.9	68.5	77.5	74.6	61.3	68.1	127.6	110.2	119.2
1939	ND	ND	ND	79.2	60.7	70.2	133.1	109.6	121.7

Sources: Norkus, Ambrulevičiūtė, Markevičiūtė, Morkevičius, & Žvaliauskas (2021a, 2021b, 2021c).

data to calculate life expectancy. During the entire interwar period, infant mortality in Lithuania was nearly two times higher than in the two other Baltic states. It is also important to note that infant and child mortality decreased substantially in all three Baltic states, while remaining life expectancy at adult age increased insignificantly or stagnated. In particular, the last statement applies to Lithuanians aged 50 or older.

Figure 4 shows changes in the probability of dying in age groups 0–5, 5–15, and 15–50 for both genders combined, males, and females in Lithuania 1925–1934. The graphs show an uneven progress in the reduction of mortality in 0–5 and 5–15 age groups. After a strong initial decline between 1925 and 1926, both indicators were fluctuating around the same level until 1929. After that the probability of dying between ages 0 and 5 started a rapid decline, with a short interruption in 1932, reaching a record low in 1933, about 60% decline since 1925. The probability of dying between ages 5 and 15 first showed a steep increase reaching a peak in 1930, followed by a rapid decline until 1933. Finally, the adult probability of dying, denoted as q(15–50), remained at a relatively high level and even increased until 1927, but steeply dropped in 1928 and thereafter remained almost unchanged until 1934.

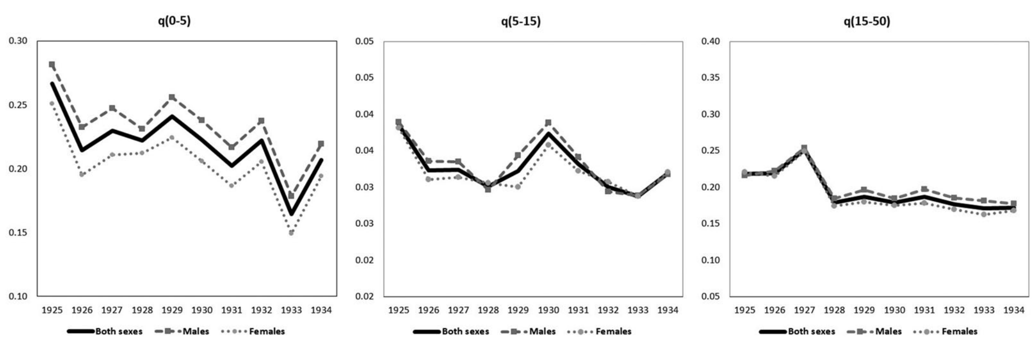

Figure 4. Changes in probability of dying between ages 0 and 5 (q(0–5)), ages 5 and 15 (q(5–15)), and ages 15 and 50 (q(5–50)), 1925–1934. Own production.

Table 8. Changes within age groups to the total change in life expectancy at birth, Lithuania, 1925–1933.

Age group	Both sexes	Males	Females
0	4.4	4.3	4.5
1–4	2.1	2.1	2.0
5–14	0.4	0.4	0.4
15–49	1.3	0.9	1.6
50+	−0.3	−0.2	−0.4
Total	7.9	7.6	8.1

While for Estonia and Latvia the end of the first year was the year of top remaining life expectancy, this was not the case of Lithuania. As for the male population, five-year-old boys recorded the top remaining life expectancy. Again, this indicates significantly higher mortality levels for Lithuanian infants and children. However, in the older age groups the disadvantage of Lithuania in remaining life expectancy faded and even developed to slightly higher remaining life expectancy. Older Lithuanian men generally recorded a higher remaining life expectancy than their Estonian and even in some cases their Latvian peers. This can be explained by higher infant and child mortality, which normally represents an early selection for survival. However, it didn't apply to Lithuanian women, whose remaining life expectancy was shorter than that of their Estonian and especially Latvian peers.

Table 8 illustrates the age-specific contributions of mortality change between the bottom in 1925 and the peak in 1933 in Lithuania. Between these two years, life expectancy increased by 8.1 years. The decomposition analysis shows that the main driver of life expectancy progress was declining infant and child mortality in the age group 1–4. Reduction of infant mortality alone explains more than 50% of the total increase in life expectancy at birth. In fact, decreases in both infant and child mortality at age 1–4 years accounted for around 80% of the total longevity improvement. Meanwhile, the contribution of declining adult mortality was important (around 20%) only for female life expectancy increase, probably due to the progress in combatting maternal mortality. The last age group 50+ shows small negative contributions, suggesting increasing mortality. Due to potential data quality problems and modelling-based estimation, the results for the oldest group should be treated with caution.

Adult Lithuanian women's disadvantage in the remaining life expectancy was related to the gender gap in life expectancy which was smaller in Lithuania than in the other two Baltic countries. According to Ptukha's estimates, life expectancy at birth among the ethnically Lithuanian population in 1896–1897 differed only by 1.28 years for men and women, while for Latvians and Estonians this difference was 2.94 and 2.97 years respectively. By 1925, this difference did increase to 6.96 years in Estonia, 5.65 years in Latvia, and 3.08 years in Lithuania. In 1934, which is the last available year with data based on life tables for all the three countries, the life expectancy gap between men and women was 5.38 years in Latvia, 7.29 years in Estonia, and 2.39 years in Lithuania.

The increasing gender gap in Estonia and mainland Latvia most probably is related to an earlier fertility decline. Birth complications were a major death factor for adult women before the rise of modern medicine and the advancement of the welfare state making obstetric services available for everyone. According to Neniškis (1998, p. 697), up to seven from 1000 deliveries in Lithuania annually ended with lethal outcome for mothers in 1924–1939.[4] Thus, a lesser frequency of births did increase the remaining life expectancy for women of childbearing age. This could be an important contribution for the growth in life expectancy at birth. As fertility declined, the age when women had their last child was also lowering. For example, in Estonia, the mean age of women

[4] In 1929, only 6.3% of Lithuanian mothers delivered in maternity homes or hospitals, and by 1940 this number increased only to 17% (Neniškis, 1998, p. 4).

at their last birth declined from around 39 in the 1850s birth cohorts to 32 for those born in the 1890s (Gortfelder & Puur, 2019).

It can be argued that being raised in smaller households increases the chances of survival for infants and children. This is an outcome of optimising in the context of ‘quality-quantity trade-off’ (Becker, 1960; Becker & Lewis, 1973). Children in small families may have tended to receive better care, nourishment, and a more hygienic home environment. A larger family could have increased physiological stress due to overcrowded homes. It is more difficult to keep overcrowded spaces clean, and it may be a harder challenge to adhere strictly to personal hygiene. Even if parents could afford to expand living space, children in larger families were at higher risk of infectious diseases (Hatton, 2017, pp. 183–184).[5]

This argument may seem contradicted by the slightly smaller gender gap, higher birth and natural increase rates in Latvia than in Estonia (see Katus, 1994, pp. 94–95) despite slightly higher life expectancy in Latvia. However, we would argue that higher birth and natural increase rates in interwar Latvia is the effect of the socio-economic territorial heterogeneity of Latvia (cp. Norkus et al., 2022). In its Eastern part (Latgale) they remained on Lithuanian (or even) higher level, assuring population growth at the all-Latvian level. In Estonia and mainland Latvia, the demographic transition was already over by the interwar years, when fertility declined below replacement levels.

In Estonia, a considerable part of the fertility transition as part of the demographic transition, encompassing also mortality transition, happened in cohorts that were born between the 1850s and 1900s. Estonian women born at the turn of the century, whose childbearing age was primarily in the interwar period, gave birth on average to two children. This was significantly lower than for women born in the 1850s, who gave birth to an average of 3.8 children (Gortfelder & Puur, 2019). As a result, the fertility transition in Estonia is considered to have been completed by the end of the 1920s when the total fertility rate fell below 2.1. The lowest point in the Estonian interwar fertility levels was reached in the mid-1930s (Katus & Puur, 2006). Importantly, in terms of the GDP per capita, the countries still lagged much behind Western Europe and Scandinavia (see Figure 5 and 6 below).

‘The formation of modern population in Estonia was completed prior to the Second World War, simultaneously with the pioneering countries of demographic transition in Northern and Western Europe’ (Puur, 2011, p. 74; Gortfelder & Puur, 2020). Early fertility decline, with near zero natural population increase, was one reason these countries were exposed to massive immigration from other Soviet republics during the period of Soviet rule, dramatically changing the ethnic composition of the population in these countries. There was no such early and rapid change in Lithuania, where the demographic transition started and ended later (Katus, 1990; Krūmiņš, 1993; Krūmiņš & Zvidriņš, 1976; Plakans, 1984).

The Baltic provinces ‘may have been among those scattered regions of Europe where the so-called demographic transition – a sustained decrease in fertility and mortality rates – had already begun in the middecades of the nineteenth century, a generation earlier than in surrounding areas’ (Plakans, 1995, p. 88). However, the exact timing of its beginning is still disputed. Coale and Watkins (1986) put the start of Estonian fertility decline around the 1880s. Gortfelder and Puur (2019) results suggest it could be even earlier.

For this paper, a proper closure is placing Baltic life expectancy developments into a broader context, which involves an attempted explanation of regional patterns by relating it to variation in levels of economic development. According to the prevailing wisdom in mainstream economics, there are no limits or ceilings to economic growth. However, there has been a debate regarding the limits of human life expectancy (Oeppen & Vaupel, 2002; Olshansky & Carnes, 2013). Economic

[5]Here we assume that positive relation between crowding (number of children in a household) and infant mortality, negative relation between birth spacing and infant mortality, as well as negative relation between number of children and stature or health of surviving children as adults, established in the literature (e.g. Cage & Foster, 2002; Molitoris, Kieron, & Kolk, 2019; Öberg, 2017), did hold also for interwar Baltic countries, although the replication of this research for these country cases would be very useful.

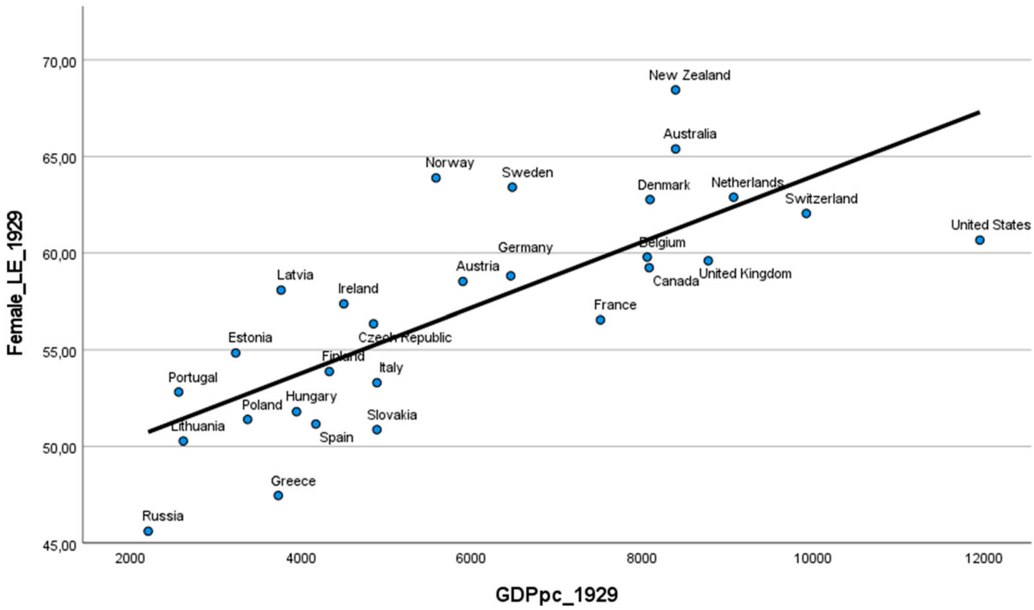

Figure 5. GDPpc (in the 2011 international $) and female life expectancy at birth in some European and Western offshoots countries in 1929. Adjusted $R^2 = .562$, standardised $\beta = .761$, $p < .001$. Data sources: MPD 2020; Norkus & Markevičiūtė, 2021, and see Table 9.

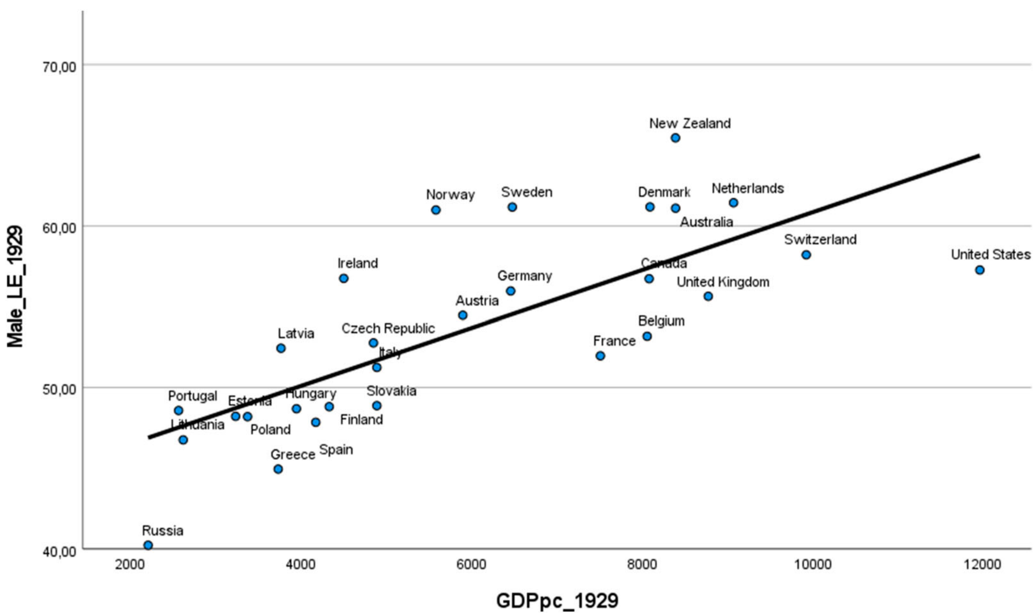

Figure 6. GDPpc (in the 2011 international $) and male life expectancy at birth in some European and Western offshoots countries. Adjusted $R^2 = 0.547$, standardised $\beta = .751$, $p < .001$. Data sources: MPD 2020; Norkus & Markevičiūtė, 2021, and see Table 9.

growth may be the strongest (McKeown, 1988) driver of life expectancy increase, with progress in biomedicine and medical technologies following next. However, despite life expectancy increases with economic growth, there are diminishing returns.

Table 9. Life expectancy in countries with population of European descent around 1929.

Nr.		Male LE	Female LE	Year	Source
1	Australia	61.10	65.39	1929	HMD
2	Austria	54.47	58.53	1930–1933	HLTD
3	Belgium	53.18	56.95	1928–1932	HMD
4	Canada	56.73	59.24	1929	HMD
5	Czech Republic	52.77	56.35	1929	HLTD
6	Denmark	61.18	62.77	1926–1930	HMD
7	Estonia	48.22	54.84	1929	Katus, 2004
8	Finland	48.82	53.88	1929	HMD
9	France	51.97	56.55	1929	HMD
10	Germany	55.97	58.82	1924–1926	HLTD
11	Greece	44.95	47.46	1928	HLTD
12	Hungary	48.69	51.80	1930–1931	HLTD
13	Ireland	56.75	57.37	1926	HLTD
14	Italy	51.25	53.30	1929	HMD
15	Latvia	52.44	58.08	1929	Katus, 2008
16	Lithuania	46.76	50.28	1929	Own estimate
17	Netherlands	61.44	62.89	1929	HMD
18	New Zealand	65.46	68.45	1934–1938	HLTD
19	Norway	60.99	63.89	1929	HMD
20	Poland	48.20	51.40	1931–1932	HLTD
21	Portugal	48.58	52.82	1932–1942	HLTD
22	Russia	40.23	45.61	1926–1927	HLTD
23	Slovakia	48.88	50.87	1929–1932	HLTD
24	Spain	47.85	51.16	1929	HMD
25	Sweden	61.17	63.41	1929	HMD
26	Switzerland	58.21	62.05	1929	HMD
27	United Kingdom	55.64	59.60	1929	HMD
28	United States	57.27	60.67	1929–1931	HLTD

Sources: Human Mortality Database (HMD), Human Life-Table Database (HLTD), Katus, 2004; 2008; own research.

This relation was analysed by Preston (1975) and is depicted in the 'Preston curve'[6] (see also Deaton, 2013; Mackenbach & Looman, 2013). This curve indicates that life expectancy in rich countries is higher than in poor countries. However, the relationship between the rise in income and life expectancy is non-linear, with diminishing return to scale. Thus, the impact of economic growth on an increase in life expectancy is strongest at low levels of output, while it weakens with high levels. Positive shifts may favour countries with respect to their output levels. New health technology may be efficient, but too expensive for poor countries. Or they may be cheap and efficient, but the issues they target may already have been removed in rich countries. Differences in the trajectories of the curves may also reflect disparities in the mortality and morbidity structures. Breakthroughs in the control of non-communicative diseases attacking old people may produce limited life expectancy effects in countries with a young population.

Health technology improvements during the interwar period provided the largest benefits for countries exiting the 'poverty trap', allowing for big life expectancy increases for countries with relatively modest economic resources (Deaton, 2013; Riley, 2001). Mass vaccination against smallpox was introduced in the Baltic countries at this time, making a larger number of infants live until the adult age. This accounts for a noticeable increase of life expectancy at birth even under stagnating remaining life expectancy in adult age. Hence, for this period the relationship between the level of economic development and life expectancy at birth is evident, as depicted in Figures 5 and 6.

We choose 1929 because it is in the middle of the interwar years, encompassing life expectancy data for all three Baltic countries (Table 9). The size of the sample (N = 28) is limited by the availability of data. The Baltic countries are still absent in the MPD, but we use comparable estimates from Norkus & Markevičiūtė, 2021. In 1929 Latvia's GDP per capita at 2011 international US dollars PPP in 1929 was 3766, Estonia's 3234, and Lithuania's 2620. Hence, there is a close

[6]See Roser, Ortiz-Ospina, & Ritchie (2013).

correspondence between the positions of Baltic countries in the country rankings according to economic performance and according to life expectancy: in both rankings, Latvia is first, Estonia next, and Lithuania closes running order.

Indeed, disparities in the GDPpc levels accounted for more than 50% of the variation in life expectancy in 1929, indicating that in the interwar period economic development was the most powerful life expectancy driver. The international standing of Estonian and Lithuanian males closely corresponded to the statistical prediction, while for Latvian males the observed life expectancy was 2.76 years above predicted value, as shown in Appendix 6. However, residuals for the Scandinavian countries were even larger. What is really intriguing, is the relatively low life expectancy in Finland, which was economically more developed than the Baltic countries by 1930 but where male life expectancy was similar to that in Estonia. It was four years shorter than that of Latvian males. Both Latvian and Estonian females enjoyed longer life expectancies than their Finnish peers.

We suggest Finland's lower ranking by life expectancy, despite its higher level of economic development, was due to the lag in the beneficial impact of the fertility transition. According to vital statistics data, Finland did lag in its demographic transition despite its economic edge. Another piece of evidence supporting this interpretation is the overperformance of Estonian and Latvian women with respect to the economic standing of their countries. In this respect, Latvian females were real outliers, displaying the fifth largest (4.7 years) positive residuals, next only to New Zealand, Australia, Sweden and Norway (see Appendix 5).[7]

Concluding discussion

The present study is the first comparison of the mortality transition in the Baltic countries during the interwar period, based on life tables for all three countries. We supplemented Katus' (2008) life tables on Estonia (1923–1938) with formerly unpublished life tables on Latvia (1925–1938) by the same author. We constructed novel annual (1×5) life tables for Lithuania, covering 1925–1934. The estimation procedure, for the first time for Lithuania in this period, adjusted for under-registration of infant mortality and corrected for old age mortality by using the Gompertz-Makeham model. We believe that such adjustments provide more realistic estimates, because unlike in Estonia and Latvia, Lithuania did not maintain civil registration but relied on the death reports by confessional communities.

By using the new data, we examine how the pace and timing of demographic and epidemiological transition in Lithuania diverged from the other two Baltic countries. The findings confirm that Lithuania was the late-comer of the demographic transition. Thus, it differed from Estonia and mainland Latvia which performed below replacement fertility already in the interwar years, indicating the completion of the demographic transition. Estonia and mainland Latvia, like France, did belong to a few countries of early demographic transition where fertility decline preceded the drop in mortality (Chesnais, 2001). In most countries of the Western mortality transition model, the fertility transition was completed only after the mortality transition. According to our findings, fertility transition ended before the completion of mortality transition in Estonia and Latvia. It is likely that the early decrease in fertility accounted for lower death rates among the Estonian and Latvian women of childbearing age compared with their Lithuanian peers. This may also account for a larger life expectancy gender gap, seen in Estonia and Latvia.

Our life expectancy data suggest that the demographic shift in the three Baltic countries can be described with the Western epidemiological model, with life expectancy levels surpassing those of ethnic Russia by more than 10 years already in 1897. During the next decades, the pace of mortality transition was most rapid in Latvia, closely followed by Estonia. In both countries, female life

[7]The GDP numbers for Norway in the MPD (2020) are probably underestimated due to the problem with oil prices and PPP calculations. Low oil prices in the base year would make the earlier Norwegian GDP low too. See Grytten (2022).

Table 10. Death causes in Baltic countries 1925–1939.

Year	Infectious and parasitic diseases (%)			Neoplasms (%)			Diseases of nervous system (%)			Diseases of circulatory system (%)			Diseases of respiratory system (%)			Diseases of digestive system (%)			External causes (%)			Other diseases (%)			Unknown causes (%)		
	EE	LT	LV Riga	EE	LT	LV Riga	EE	LT	LV Riga	EE	LT	LV Riga	EE	LT	LV Riga	EE	LT	LV Riga	EE	LT	LV Riga	EE	LT	LV Riga	EE	LT	LV Riga
1925	19.4	19.7	ND	4.4	1.6	ND	8.1	1.2	ND	10.0	4.2	ND	10.1	11.0	ND	3.7	5.5	ND	4.9	0.8	ND	26.7	29.1	ND	12.7	26.9	ND
1926	21.1	16.4	19.6	5.1	1.8	12.7	7.6	1.2	2.8	9.1	5.6	21.6	10.5	11.6	10.9	3.6	3.5	5.1	4.5	1.0	7.0	26.8	31.8	19.6	11.6	27.0	0.6
1927	22.4	14.3	21.9	5.0	1.8	12.3	7.6	1.3	2.4	9.7	5.6	22.1	11.6	18.7	9.4	4.0	4.1	5.2	4.3	2.1	6.3	25.0	26.4	19.5	10.4	25.8	0.8
1928	18.7	17.0	19.7	5.7	2.0	12.5	2.9	1.4	2.3	7.9	6.4	24.0	11.4	12.4	8.6	1.9	3.5	4.3	4.5	2.3	7.6	35.7	28.2	20.4	11.4	26.7	0.6
1929	15.4	15.0	19.4	4.2	2.0	12.7	2.7	0.8	2.3	8.3	6.6	21.3	18.2	12.4	10.2	1.4	3.2	4.5	3.9	2.3	6.5	36.2	33.4	22.6	9.8	24.2	0.5
1930	17.9	16.4	18.9	6.6	2.4	13.4	5.3	1.4	2.7	14.7	7.0	22.5	7.8	12.6	10.4	4.5	3.3	4.7	5.1	2.4	6.8	27.3	32.1	20.1	10.8	22.3	0.4
1931	16.6	14.1	18.7	6.1	2.4	13.1	4.9	1.3	2.5	15.7	7.8	24.6	9.0	15.0	9.7	4.5	3.5	5.5	4.8	2.6	6.4	27.5	32.2	19.1	10.9	20.9	0.3
1932	15.8	15.1	17.3	7.2	2.7	14.1	5.1	3.4	2.6	17.2	6.4	27.3	7.1	12.3	8.7	4.4	8.9	4.5	5.0	3.3	7.0	26.8	26.9	17.9	11.3	21.1	0.6
1933	15.1	13.5	16.2	7.4	3.4	16.0	4.3	3.5	1.8	16.4	7.7	28.0	9.0	13.5	8.8	4.2	7.2	4.4	4.6	3.3	6.5	26.4	28.1	18.0	12.7	19.8	0.3
1934	15.4	13.9	16.7	8.6	3.1	15.0	4.5	3.2	2.4	16.7	7.8	27.9	6.2	11.5	9.1	4.5	9.9	4.8	5.1	3.1	7.0	27.6	27.9	16.6	11.4	19.7	0.3
1935	14.9	14.0	13.1	8.2	3.3	13.1	4.1	3.4	2.3	18.1	9.0	33.0	7.5	14.1	9.6	4.3	6.4	4.6	4.2	3.0	6.3	28.1	29.7	17.8	10.6	17.0	0.3
1936	13.6	12.3	12.7	8.5	3.7	13.4	4.0	3.5	2.0	18.8	9.4	32.6	10.2	11.6	8.5	4.1	8.7	4.5	5.0	3.3	7.4	29.2	30.9	18.5	6.8	16.5	0.4
1937	14.5	11.7	12.2	9.3	3.5	13.1	4.2	3.2	1.7	18.8	9.6	33.0	8.3	13.5	10.7	4.2	7.6	4.2	4.9	3.5	6.5	29.1	32.2	17.9	6.7	15.3	0.7
1938	ND	12.6	12.3	ND	3.7	13.1	ND	3.2	1.7	ND	10.0	32.8	ND	13.6	10.3	ND	7.3	4.4	ND	3.9	7.1	ND	36.8	17.7	ND	8.9	0.5
1939	ND	12.8	ND	ND	3.3	ND	ND	3.2	ND	ND	9.8	ND	ND	16.4	ND	ND	7.0	ND	ND	3.3	ND	ND	33.8	ND	ND	10.4	ND

Note: The country name abbreviations refer to: EE – Estonia; LT – Lithuania; LV – Latvia. Data sources: et al., 2022a; 2022b; 2022c.

expectancy reached 60 years threshold in the 1930s. Lithuania remained a laggard due to high infant mortality, that was nearly double of the Estonian and Latvian levels.

In all three Baltic countries, however, the decrease of infant and child mortality from infectious diseases was a major driver for the increasing life expectancy. Disparities in mortality transition across the Baltic countries are explained mainly by differences in their economic development, measured by levels of GDP per capita. In a broader, international context, Latvian women's life expectancy emerged as the only outlier with respect to cross-country variation in GDP. Accepting the findings of recent research (Norkus, Morkevičius, & Markevičiūtė, 2021), Latvia's leadership in the advancement of the welfare state may provide best explanation of this phenomenon.

Life expectancy data also suggest that the replacement of infectious diseases as the dominant cause of mortality by man-made and degenerative diseases (and so the epidemiological transition itself) was still incomplete in the 1930s. We elaborate on this hypothesis by comparing death causes in the three Baltic countries, using newly collected historical data on the causes of death (see Table 10). Although mortality from infectious and parasitic diseases declined over 15 years documented by data, in the late 1930s 20–25% of all deaths still were caused by these diseases and closely related diseases of respiratory system, including influenza and pneumonia.

Latvia looks like an exception, because 45.9% of all deaths in 1938 were caused by degenerative diseases, like neoplasms and diseases of circulatory system. It may be tempting to consider this as another piece of evidence of Latvia's leadership in the mortality transition and claim that in this country it was nearly complete by WWII, defining completion as absolute dominance (at least 50%) of degenerative diseases of all death causes. However, for Latvia data on death causes are available for Riga only, the only metropolitan city in the interwar Baltics. At the time of the last Latvian interwar census in 1935 only 34.62% of total population lived in cities and towns (Norkus et al., 2022d).

So we may assume that the national Latvian causes of death pattern was close to Estonia, with mortality from degenerative diseases amounting to 25–30% of deaths. This is in sharp contrast to the Lithuanian pattern (circa 15%), but is still far from the 50% mark. We should be cautious, however, taking these data at face value because of the huge cross-country difference in the share of unknown death causes, which itself provides another important piece of evidence about disparities in the accessibility of medical services. In Lithuania, the share of deaths from unknown causes was larger by factor 2 or more than in Estonia, while in Riga the share of such deaths was less than 1%. This indicates that under urban conditions nearly all cases of death were examined by medical professionals but this was not the case under rural conditions in the interwar Baltic states (most probably, also in Latvia).

Our study suggests that further work is still needed to address data and methodological challenges in mortality and population statistics of the inter-war period. First, more efforts are needed to improve population and international migration data estimates. Second, the possibility of extending the current study period using census data from the German occupation years (1941 in Estonia, 1942 in Lithuania, and 1943 in Latvia) should be considered. Finally, completeness of death registration during the inter-war period should be validated with further research to improve the reliability of age-specific mortality rates, especially at infant and child ages.

To conclude, the list of most promising issues for further research focuses on cross-country and cross-time variation of life expectancy in the Baltic countries, including regional disparities in life expectancy (apparently, they were largest in Latvia), which is related to regional differences in timing of fertility and mortality transitions. Another issue is the reason of the early start and early completion of the demographic transition in Estonia and Latvia, which seems out of tune with levels of their economic progress. This paper expands the list with the topic of life expectancy overperformance among Latvian women during the interwar period.

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