

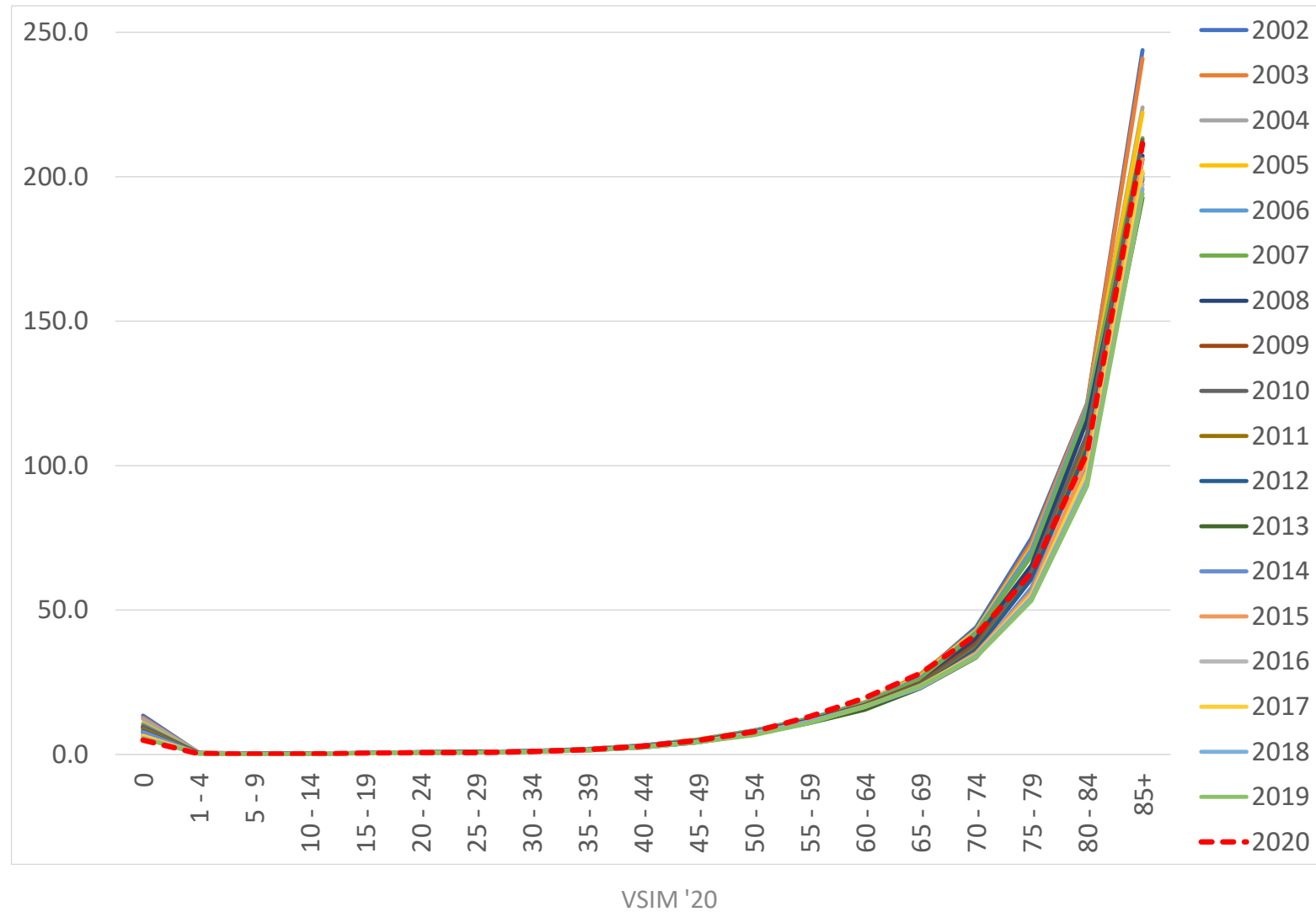
How does fertility affect mortality?

Kaloyan Haralampiev

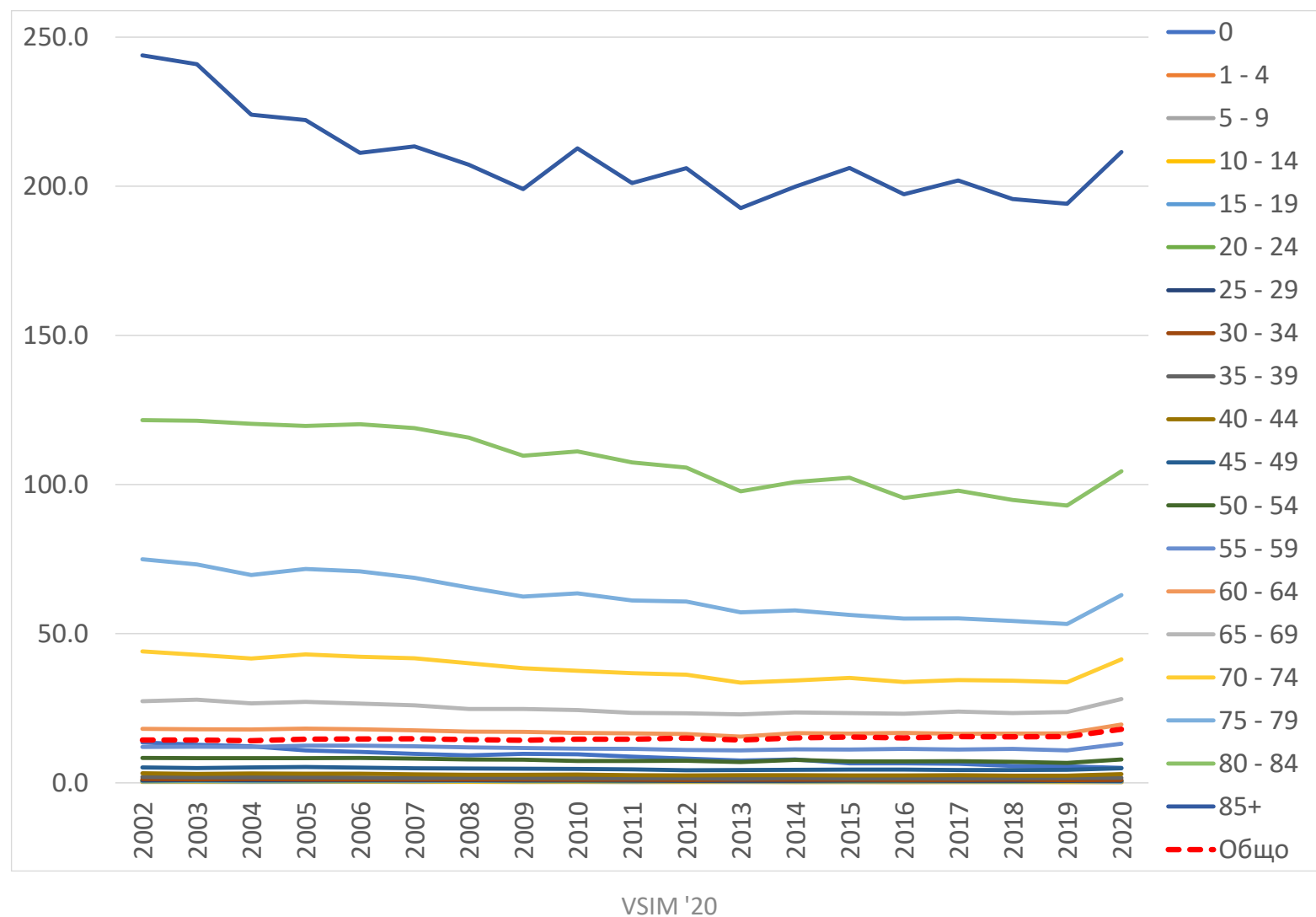
Acknowledgements

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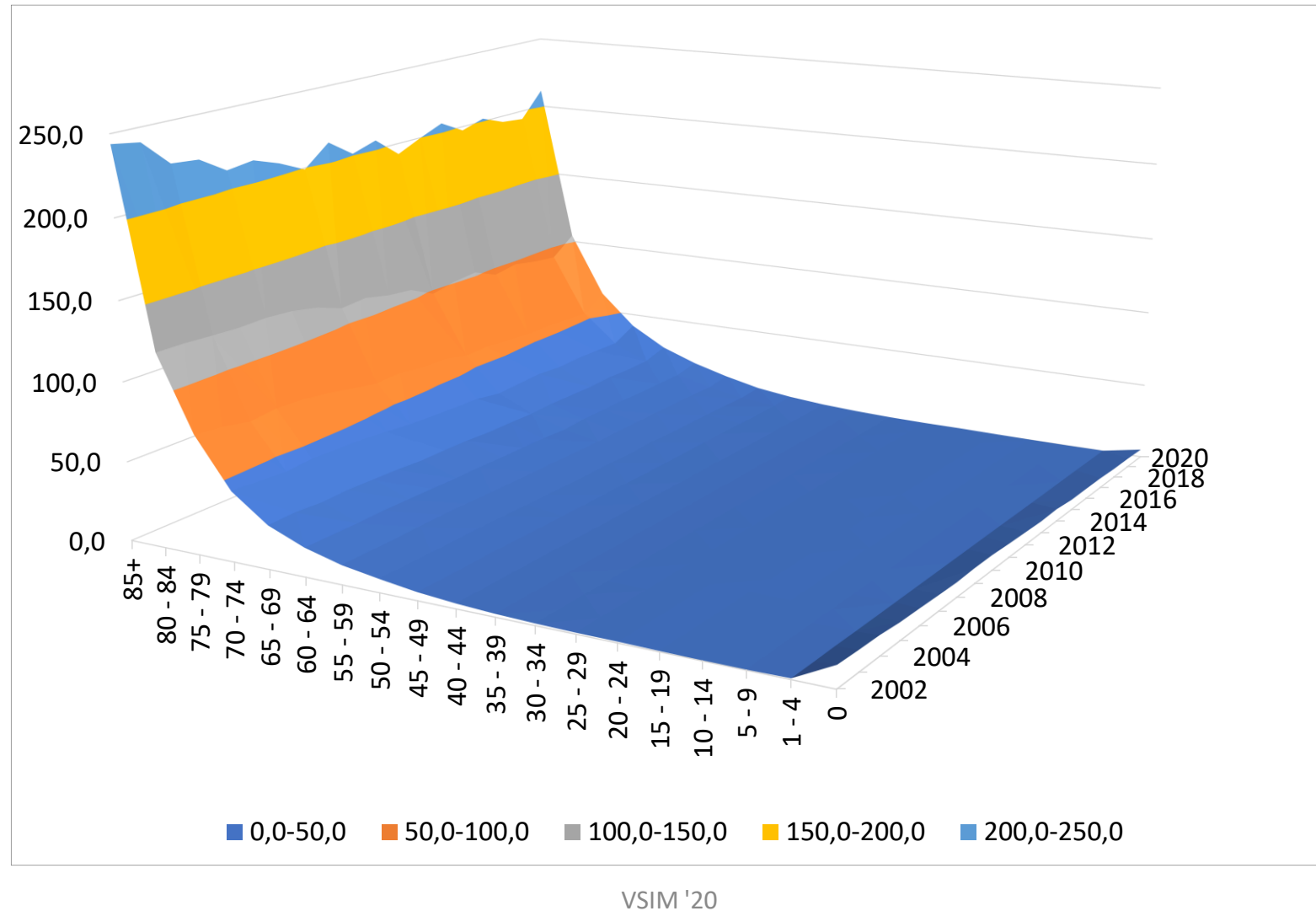
Death rates by age groups



Death rates by years



Death rates by years and age groups



Death rates by age groups

	СМЪРТНОСТ ПО ВЪЗРАСТ (5 ГОДИШНИ ВЪЗРАСТОВИ ГРУПИ)																			
Възраст	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	
0	13.5	12.8	12.3	10.9	10.4	9.7	9.2	9.7	9.6	8.8	8.1	7.5	7.8	6.5	6.5	6.4	5.7	5.5	5.0	
1 - 4	0.7	0.6	0.7	0.6	0.5	0.5	0.5	0.4	0.4	0.4	0.4	0.4	0.3	0.3	0.3	0.3	0.4	0.3	0.2	
5 - 9	0.3	0.2	0.2	0.3	0.3	0.2	0.3	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.1	0.2	0.1	0.1	
10 - 14	0.2	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	
15 - 19	0.5	0.5	0.5	0.4	0.5	0.6	0.6	0.5	0.5	0.5	0.5	0.4	0.5	0.5	0.5	0.4	0.5	0.5	0.4	
20 - 24	0.8	0.8	0.8	0.7	0.8	0.8	0.8	0.7	0.7	0.6	0.6	0.7	0.6	0.6	0.6	0.6	0.6	0.6	0.6	
25 - 29	0.8	1.0	0.9	0.9	0.9	0.9	0.9	0.8	0.8	0.8	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.6	
30 - 34	1.2	1.2	1.3	1.1	1.1	1.1	1.1	1.1	1.0	1.0	1.0	1.0	1.1	1.0	1.0	0.9	1.0	0.9	1.0	
35 - 39	1.9	1.8	1.8	1.8	1.8	1.6	1.7	1.6	1.6	1.6	1.5	1.4	1.6	1.4	1.5	1.4	1.5	1.6	1.7	
40 - 44	3.2	3.0	3.1	3.1	3.1	2.8	2.7	2.7	2.8	2.6	2.5	2.5	2.6	2.5	2.5	2.6	2.4	2.4	2.9	
45 - 49	5.2	5.0	5.1	5.3	5.1	4.9	4.8	4.7	4.7	4.5	4.2	4.3	4.3	4.4	4.4	4.3	4.2	4.3	4.9	
50 - 54	8.4	8.2	8.3	8.3	8.3	8.1	7.8	7.7	7.3	7.3	7.4	7.0	7.7	7.2	7.2	7.3	7.0	6.7	7.9	
55 - 59	12.1	12.1	12.0	12.5	12.5	12.3	11.8	11.6	11.4	11.4	11.0	10.9	11.3	11.2	11.4	11.2	11.4	10.8	13.1	
60 - 64	18.1	18.0	17.9	18.2	17.9	17.6	17.1	17.1	16.7	16.6	16.4	15.5	16.6	16.5	16.7	16.5	16.5	16.6	19.6	
65 - 69	27.3	27.9	26.6	27.2	26.6	26.0	24.8	24.8	24.4	23.5	23.3	23.0	23.6	23.4	23.1	23.9	23.4	23.7	28.1	
70 - 74	44.0	42.9	41.7	43.1	42.3	41.7	40.1	38.4	37.5	36.7	36.3	33.6	34.3	35.2	33.8	34.5	34.2	33.7	41.4	
75 - 79	74.9	73.2	69.7	71.7	70.9	68.7	65.5	62.4	63.5	61.1	60.8	57.2	57.8	56.3	55.1	55.2	54.3	53.3	62.9	
80 - 84	121.6	121.4	120.4	119.7	120.2	118.9	115.7	109.6	111.1	107.4	105.7	97.7	100.9	102.3	95.5	97.9	94.9	92.9	104.4	
85+	243.9	240.9	224.0	222.2	211.2	213.4	207.3	199.1	212.7	201.1	206.1	192.7	199.8	206.2	197.3	201.9	195.7	194.1	211.5	
Общо	14.3	14.3	14.2	14.6	14.7	14.8	14.5	14.2	14.6	14.6	15.0	14.4	15.1	15.3	15.1	15.5	15.4	15.5	18.0	

Additive factorial analysis

$$\Delta \bar{m} = \bar{m}_1 - \bar{m}_0 = \sum_i m_{1i} s_{1i} - \sum_i m_{0i} s_{0i} = \sum_i s_{min,i} \Delta m_i + \sum_i m_{min,i} \Delta s_i + \sum_i h \Delta m_i \Delta s_i$$

m_i - death rates by age groups

s_i - population structure by age

$$\Delta m_i = m_{1i} - m_{0i}$$

$$h = \begin{cases} \Delta s_i = s_{1i} - s_{0i} \\ 1, \text{ if } \Delta m_i > 0 \text{ and } \Delta s_i > 0 \\ 0, \text{ if } \Delta m_i > 0 \text{ and } \Delta s_i < 0 \\ 0, \text{ if } \Delta m_i < 0 \text{ and } \Delta s_i > 0 \\ -1, \text{ if } \Delta m_i < 0 \text{ and } \Delta s_i < 0 \end{cases}$$

(Христов, 2018: 9-10)

Additive factorial analysis between 2002 and 2019

$$\begin{aligned}\Delta\bar{m} &= \bar{m}_1 - \bar{m}_0 = 15,5 - 14,3 = 1,2 = -3,0 + 4,2 + 0,0 \\ &= \sum_i s_{min,i} \Delta m_i + \sum_i m_{min,i} \Delta s_i + \sum_i h \Delta m_i \Delta s_i\end{aligned}$$

$$\sum_i s_{min,i} \Delta m_i = -3,0$$

$$\sum_i m_{min,i} \Delta s_i = 4,2$$

$$\sum_i h \Delta m_i \Delta s_i = 0,0$$

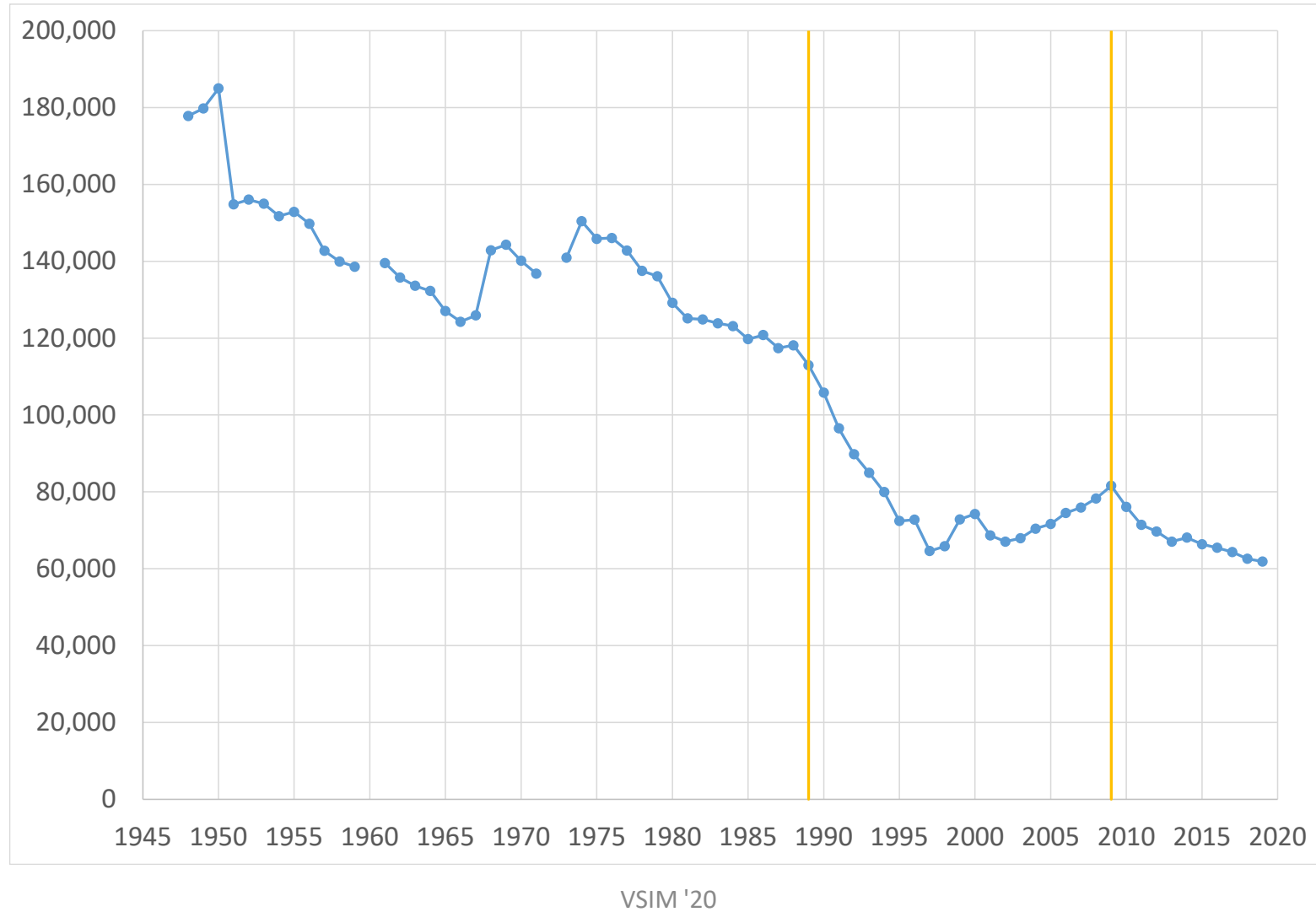
Changes of death rates by age groups and age structure between 2002 and 2019

Възраст	Δm	Δs
0	-8.0	0.001
1 - 4	-0.4	0.005
5 - 9	-0.1	0.004
10 - 14	-0.1	-0.013
15 - 19	0.0	-0.023
20 - 24	-0.1	-0.028
25 - 29	-0.1	-0.016
30 - 34	-0.3	-0.002
35 - 39	-0.3	0.004
40 - 44	-0.8	0.008
45 - 49	-0.8	0.003
50 - 54	-1.7	-0.006
55 - 59	-1.2	0.004
60 - 64	-1.5	0.014
65 - 69	-3.6	0.010
70 - 74	-10.3	0.010
75 - 79	-21.7	0.003
80 - 84	-28.7	0.010
85+	-49.7	0.012

2019 – 10 = 2009

2019 – 30 = 1989

Births



Changes of death rates by age groups and age structure between 2002 and 2019

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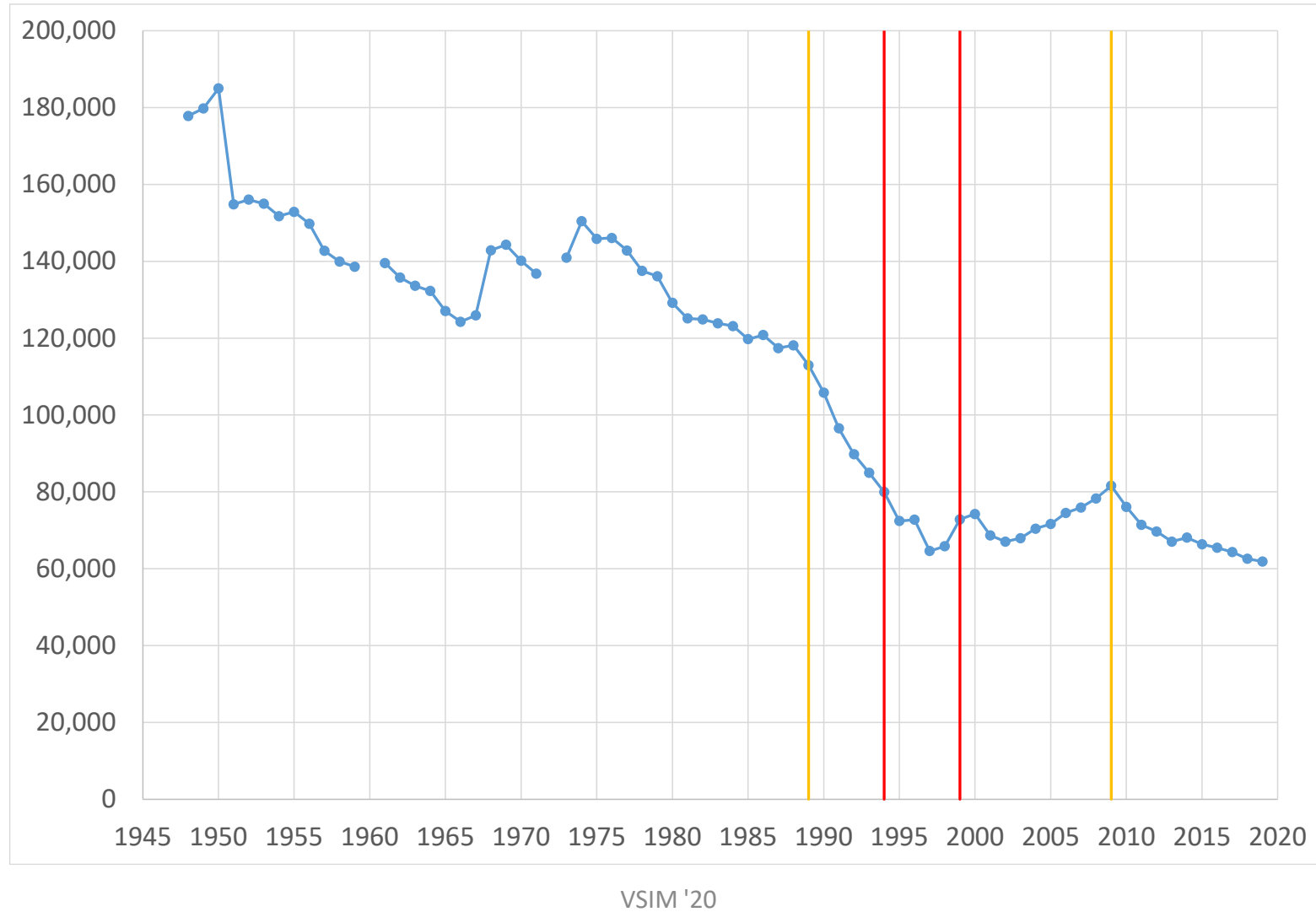
$$2019 - 10 = 2009$$

$$2019 - 30 = 1989$$

$$2019 - 20 = 1999$$

$$2019 - 25 = 1994$$

Births



Changes of death rates by age groups and age structure between 2002 and 2019

Възраст	Δm	Δs
0	-8.0	0.001
1 - 4	-0.4	0.005
5 - 9	-0.1	0.004
10 - 14	-0.1	-0.013
15 - 19	0.0	-0.023
20 - 24	-0.1	-0.028
25 - 29	-0.1	-0.016
30 - 34	-0.3	-0.002
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70 - 74	-10.3	0.010
75 - 79	-21.7	0.003
80 - 84	-28.7	0.010
85+	-49.7	0.012

2019 – 10 = 2009

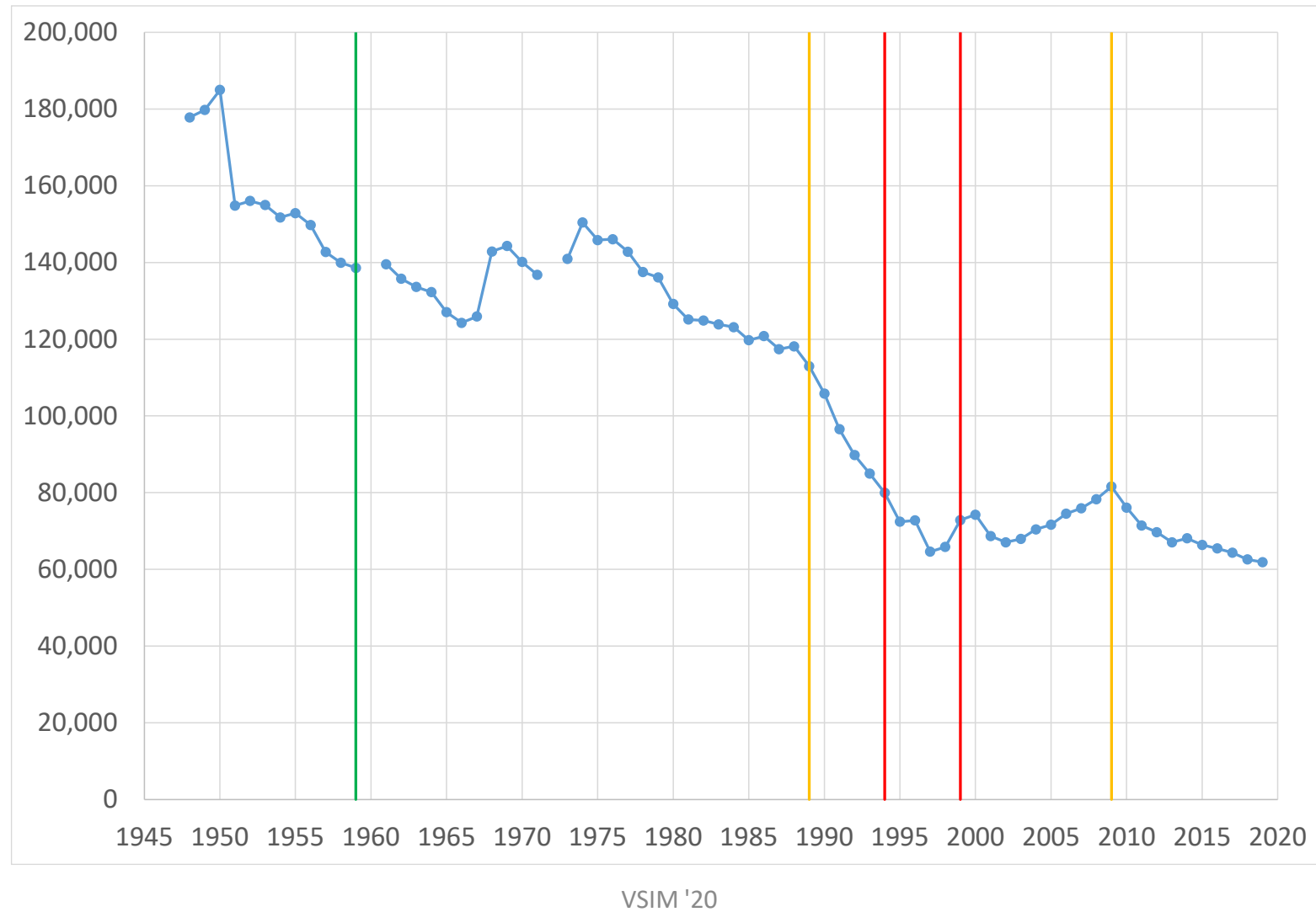
2019 – 30 = 1989

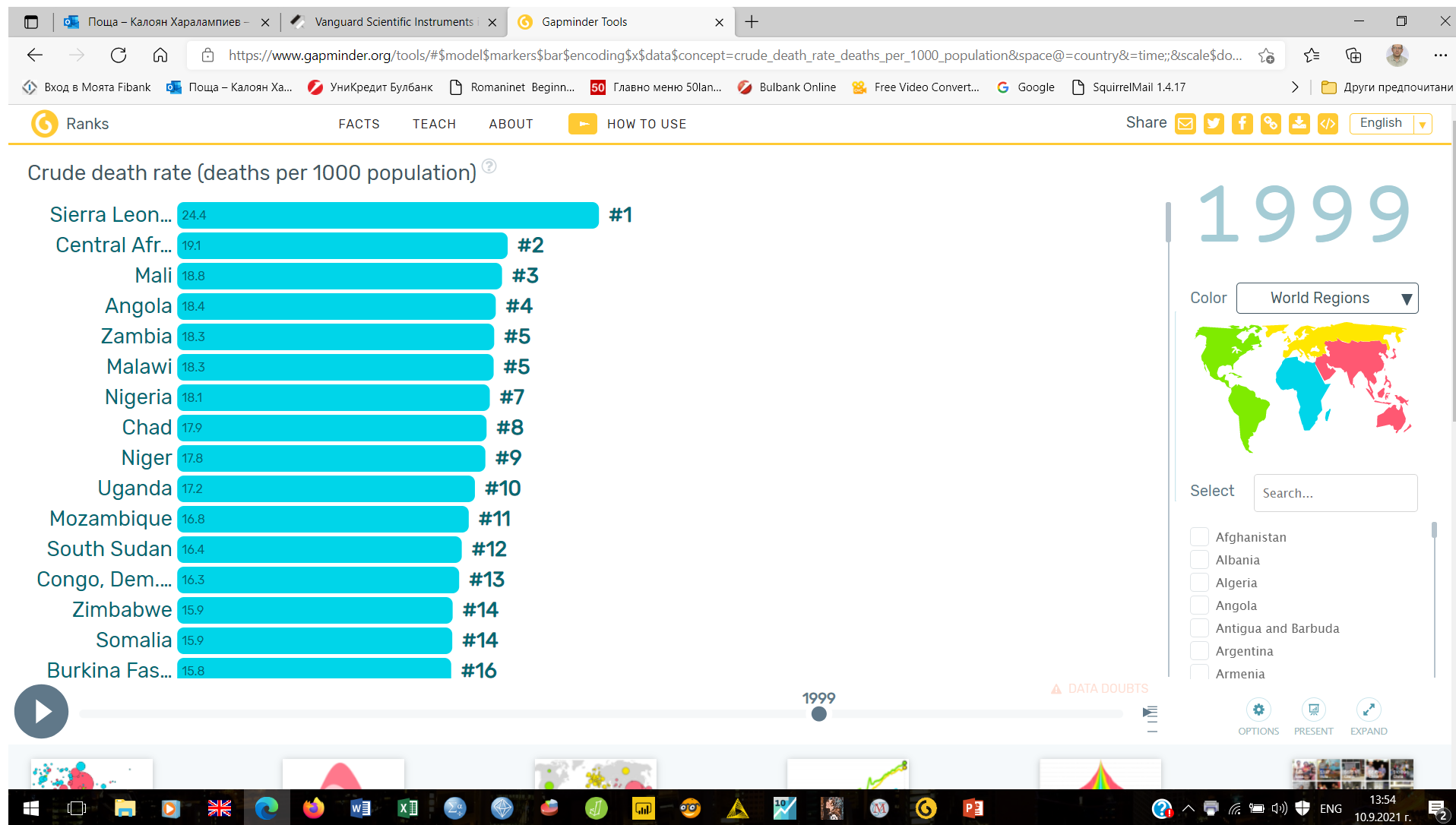
2019 – 20 = 1999

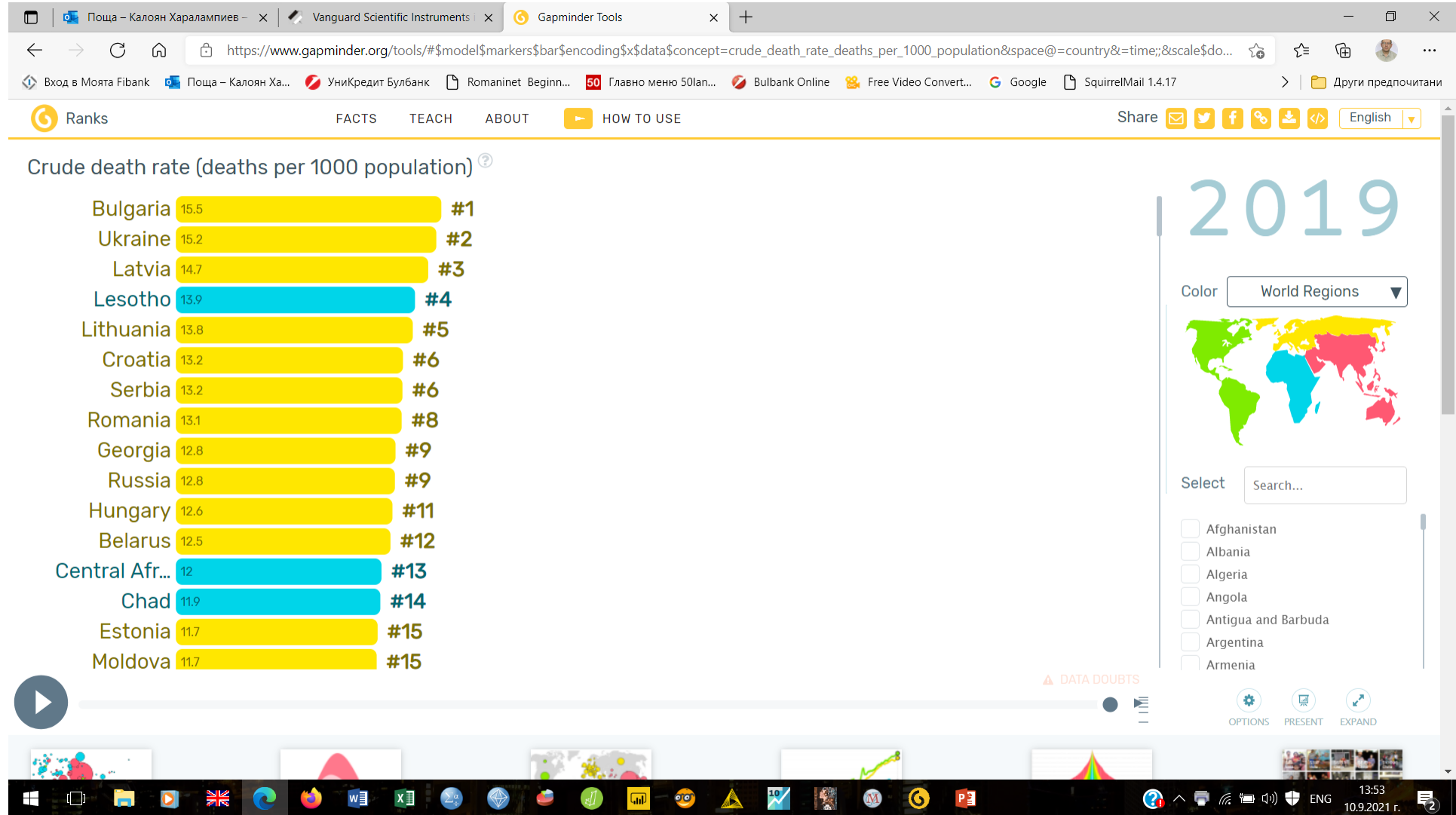
2019 – 25 = 1994

2019 – 60 = 1959

Births







References

Христов, Е. 2018. Адитивен факторен анализ на средните цени от еднородни съвкупности на стоки с дискретната нечетна функция на математическия сигнум. Статистика, 1/2018

Additive factorial analysis between 2019 and 2020

$$\begin{aligned}\Delta\bar{m} &= \bar{m}_1 - \bar{m}_0 = 18,0 - 15,5 = 2,5 = 2,3 + 0,2 + 0,0 \\ &= \sum_i s_{min,i} \Delta m_i + \sum_i m_{min,i} \Delta s_i + \sum_i h \Delta m_i \Delta s_i\end{aligned}$$

$$\begin{aligned}\sum_i s_{min,i} \Delta m_i &= 2,3 \\ \sum_i m_{min,i} \Delta s_i &= 0,2 \\ \sum_i h \Delta m_i \Delta s_i &= 0,0\end{aligned}$$

Additive factorial analysis between 2002 and 2020

$$\begin{aligned}\Delta\bar{m} &= \bar{m}_1 - \bar{m}_0 = 18,0 - 14,3 = 3,7 = -1,2 + 4,9 + 0,0 \\ &= \sum_i s_{min,i} \Delta m_i + \sum_i m_{min,i} \Delta s_i + \sum_i h \Delta m_i \Delta s_i\end{aligned}$$

$$\begin{aligned}\sum_i s_{min,i} \Delta m_i &= -1,2 \\ \sum_i m_{min,i} \Delta s_i &= 4,9 \\ \sum_i h \Delta m_i \Delta s_i &= 0,0\end{aligned}$$

Additive factorial analysis between 2007 and 2020

$$\begin{aligned}\Delta\bar{m} &= \bar{m}_1 - \bar{m}_0 = 18,0 - 14,8 = 3,2 = -0,4 + 3,6 + 0,0 \\ &= \sum_i s_{min,i} \Delta m_i + \sum_i m_{min,i} \Delta s_i + \sum_i h \Delta m_i \Delta s_i\end{aligned}$$

$$\sum_i s_{min,i} \Delta m_i = -0,4$$

$$\sum_i m_{min,i} \Delta s_i = 3,6$$

$$\sum_i h \Delta m_i \Delta s_i = 0,0$$