

1 Table S1 Lag and GCV of the selected models.

Sex	Underlying cause	Age group											
		60-64		65-69		70-74		75-79		80-84		85-	
		Lag	GCV	Lag	GCV	Lag	GCV	Lag	GCV	Lag	GCV	Lag	GCV
All	Circulatory disease	0	1.01	0	1.12	0	1.19	1	1.23	0	1.55	1	2.14
	IHD	0	1.17	1	1.01	0	1.07	0	1.14	0	1.17	2	1.56
	Stroke	0	1.01	0	1.17	1	1.20	1	1.11	1	1.32	1	1.59
Male	Circulatory disease	0	1.00	0	1.12	0	1.20	1	1.25	0	1.25	2	1.39
	IHD	3	1.16	2	1.01	2	1.05	2	1.15	0	1.05	2	1.16
	Stroke	0	0.96	0	1.18	0	1.23	1	1.20	0	1.18	2	1.21
Female	Circulatory disease	2	1.06	0	1.14	1	1.12	1	1.01	1	1.26	1	1.81
	IHD	3	1.26	1	1.07	0	1.09	0	1.04	0	1.04	1	1.37
	Stroke	2	1.10	1	1.19	1	1.18	1	1.03	3	1.17	0	1.43

2 *People aged 60 years or more;

3 GCV: the minimized generalized cross-validation score of the generalized additive model fitted

4 Table S2 Annual age-specific influenza-associated excess mortality rates (per 100,000 persons) for IHD in older adults, Shanghai, China, 2010-2019.

Year	Age group											
	60-64		65-69		70-74		75-79		80-84		85-	
	ER	95%CI	ER	95%CI	ER	95%CI	ER	95%CI	ER	95%CI	ER	95%CI
2010	1.7	0.27,3.06	2.67	0.55,4.7	7.27	0.84,13.89	12.62	2.48,22.75	57.71	39.1,77.95	113.23	88.21,139.16
2011	1.61	0.37,2.71	1.48	-0.08,2.93	6.5	0.93,11.91	14.69	5.01,24.37	56.07	38.81,73.32	80.91	61.1,101.76
2012	1.38	-0.37,2.9	4.57	1.51,7.57	13.71	3.08,23.61	22.86	4.79,41.13	86.72	54.88,116.71	227.94	186.24,271.08
2013	0.49	-0.56,1.34	1.52	0.37,2.59	4.76	1.79,7.37	7.97	3.49,12.6	43.83	29.93,56.71	80.16	66.67,93.79
2014	2.07	0.08,3.76	4.77	1.73,7.53	13.56	6.19,21.06	21.98	10.12,33.82	94.73	70.48,119.86	256.1	220.24,294.44
2015	2.23	0.08,4.19	5.42	1.86,8.85	15.84	4.79,26.4	22.23	6.17,37.97	96.92	67.81,125.72	265.36	218.71,314.42
2016	1.41	0.2,2.43	2.84	0.95,4.56	10.73	4.84,16.43	17.54	9.41,25.61	68.4	52.69,84.62	155.96	133.7,181
2017	1.16	-0.62,2.61	3.56	0.89,5.89	11.89	3.96,18.69	19.46	6.56,32.14	69.48	46.17,90.69	218.35	181.69,255
2018	2.4	0.57,4.01	3.16	0.03,5.97	10.21	0.58,19.04	19.11	5.21,32.45	77.56	55.21,98.62	181.23	138.84,222.86
2019	2.97	0.75,4.82	4.81	1.45,7.88	16.85	7.38,26.02	30.25	15.41,45.34	114.53	89.63,141.75	286.93	244.56,332.82
Average	1.79	0.34,3.06	3.59	1.33,5.63	11.34	4.71,17.63	18.7	7.79,28.53	77.56	58.25,97.58	193.06	165.42,222.97

5 ER, excess rate, CI, confidence interval, IHD, Ischemic heart disease.

6 Table S3 Annual age-specific influenza-associated excess mortality rates (per 100,000 persons) for Stroke in older adults, Shanghai, China, 2010-2019.

Year	Age group											
	60-64		65-69		70-74		75-79		80-84		85-	
	ER	95%CI	ER	95%CI	ER	95%CI	ER	95%CI	ER	95%CI	ER	95%CI
2010	0.69	-1.25,2.62	-0.59	-5.14,3.09	8.81	1.16,16.46	24.56	13.15,35.12	43.48	24.26,62.24	68.4	37.73,101.01
2011	1.9	0.18,3.6	0.26	-3.58,3.39	8.56	2.39,15.14	21.67	11.77,30.17	36.92	20.16,54.56	48.37	23.91,73.45
2012	0	0,0	1.13	-4.44,6.24	14.6	4.88,23.98	34.19	18.73,49.07	64.52	37.8,90.62	129.06	82.83,174.64
2013	0	0,0	3.72	1.46,5.79	7.17	4.06,10.13	11.31	6.71,15.82	26.54	17.09,35.73	70.3	52.23,88.07
2014	0.23	-2.15,2.5	4.08	-0.36,7.98	15.45	8.78,21.76	27.2	18.18,35.88	64.02	43.92,84.19	151.75	113.06,189.53
2015	0	0,0	2.12	-3.2,6.74	15.86	6.89,24.86	28.96	16.89,40.02	62.07	39.02,84.59	143.8	98.54,188.01
2016	0.57	-0.84,1.97	2.78	0.25,5.09	10.57	6.17,14.78	19.68	13.29,25.91	40.97	28.69,53.34	93.53	68.18,116.17
2017	0	0,0	3.29	-0.17,6.31	13	6.58,18.91	22.04	12.45,30.68	44.17	28,60.25	137.61	100.26,173.7
2018	1.93	0.15,3.68	0.56	-3.43,3.96	9.19	2.02,16.25	23.22	12.53,32.61	38.15	21.74,55.45	72.21	35.52,110.6
2019	1.97	-0.31,4.38	3.68	-1.5,8.21	16.69	8.93,24.44	33.7	22.39,44.13	56.58	38.61,74.92	157.9	111.62,202.33
Average	0.56	-1.24,2.38	2.24	-1.53,5.46	12.09	6.12,17.86	24.59	16.01,32.68	47.78	32.64,63.3	110.05	78.13,139.53

7 ER, excess rate, CI, confidence interval

8 TableS4 Excess cardiovascular mortality rates(per 100,000 persons) associated with influenza type/subtypes by age in older men in Shanghai, China, 2010-2019.

Influenza type/subtypes	Underlying cause	60-64 years		65-69 years		70-74 years		75-79 years		80-84 years		85- years	
		ER	95%CI	ER	95%CI	ER	95%CI	ER	95%CI	ER	95%CI	ER	95%CI
Influenza	CVD	1.44	-2.66,5.63	9.03	0.97,16.28	37.8	25.3,50.47	55.76	36.22,74.93	154.74	117.72,188.92	353.57	286.05,424.37
	IHD	1.6	-0.74,3.5	5.11	1.4,8.54	11.34	4.71,17.63	18.7	7.79,28.53	77.56	58.25,97.58	191.19	147.96,233.56
	Stroke	0.12	-2.79,2.95	3.88	-1.8,9.48	21.4	11.02,31.37	30.91	16.27,44.94	66.83	41.42,91.42	139.07	96.2,181.37
A(H1N1)	CVD	2.75	1.02,4.47	2.76	-0.24,6.01	10.15	4.34,15.31	17.13	9.42,24.86	50.39	36.86,64.84	58.95	27.83,92.3
	IHD	0.45	-0.45,1.39	1.32	-0.33,2.92	2.84	-0.1,5.76	5.81	1.53,9.9	25.97	17.88,34.26	34.36	15.66,54.17
	Stroke	1.49	0.31,2.68	1.9	-0.33,4.19	4.39	-0.14,8.57	10.35	4.36,15.89	20.41	9.57,30.56	13.97	-6.99,34.54
A(H3N2)	CVD	0	0,0	6.81	1.83,11.41	20.91	12.31,28.89	22.86	10.73,34.65	63.52	38.83,85.93	209.81	158.97,259.62
	IHD	0.13	-1.56,1.7	1.09	-1.64,3.63	5.72	1.09,10.19	8.41	0.98,15.25	30.49	16.86,43.21	106.12	75.48,135.16
	Stroke	0	0,0	4.78	0.92,8.46	12.69	6.16,18.93	10.38	0.69,19.06	30.22	13.95,47.07	92.36	60.8,123.53
B	CVD	0.96	-2.02,4.18	0	0,0	7.54	-3,17.49	16.67	0.7,31.6	44.01	17.31,72.41	89.88	38.47,141.98
	IHD	1.04	-0.54,2.5	2.79	0.19,5.12	2.99	-2.27,7.9	4.77	-3.3,12.74	23.24	8.98,38.4	54.17	20.45,88.5
	Stroke	0.63	-1.41,2.66	0	0,0	4.72	-3.06,12.45	10.67	0.04,21.25	17.24	-1.72,35.02	34.04	0.04,66.46

9 ER, excess rate, CI, confidence interval, CVD, cardiovascular disease, IHD, Ischemic heart disease.

10 TableS5 Excess cardiovascular mortality rates(per 100,000 persons) associated with influenza type/subtypes by age in older women in Shanghai, China, 2010-2019.

Influenza type/subtypes	Underlying cause	60-64 years		65-69 years		70-74 years		75-79 years		80-84 years		85- years	
		ER	95%CI	ER	95%CI	ER	95%CI	ER	95%CI	ER	95%CI	ER	95%CI
Influenza	CVD	3.59	1.37,5.7	4.54	-0.66,9.46	13.31	4.49,22.15	37.24	23.72,50.07	90.99	63.93,120.17	329.2	272.81,395.45
	IHD	1.58	0.44,2.53	1.09	-1.65,3.37	6.43	0.69,11.64	15.33	7.44,23.37	57.06	42.2,72.03	213.8	176.33,249.18
	Stroke	1.73	-0.05,3.29	0	0,0	6.07	-1.67,13.16	19.14	9,29.03	34.66	17.82,50	109.4	72.3,147.39
A(H1N1)	CVD	1.74	0.78,2.52	0.95	-1.19,2.97	5.15	1.45,8.79	9.66	4.47,15.2	23.91	13.18,35.32	56.06	27.26,83.67
	IHD	0.18	-0.34,0.68	0	0,0	1.09	-1.39,3.37	7.24	3.75,10.39	12.32	5.79,19.08	30.39	13.84,47.69
	Stroke	1.01	0.27,1.68	0.95	-0.53,2.33	3.43	0.67,6.01	3.24	-0.99,7.67	8.38	0.78,15.43	31.44	15.47,47.33
A(H3N2)	CVD	0.76	-0.8,2.3	5.74	2.55,9.03	4.25	-1.95,9.89	16.38	8.02,25.39	44.76	28.65,63.12	184.15	142.11,227.65
	IHD	0.64	-0.25,1.33	2.48	0.71,3.97	3.04	-0.44,6.27	5.98	0.28,11.39	28.62	12.07,31.72	108.28	82.58,134.37
	Stroke	0	0,0	0.77	-1.75,3.02	1.4	-3.63,5.64	8.81	2.4,15.57	13.93	9.78,33.15	55.32	28.64,82.06
B	CVD	1.18	-0.46,2.77	0	0,0	4.1	-2.96,10.5	11.71	1.28,22.15	23.53	4.25,42.95	93.68	45.75,141.76
	IHD	0.8	0.01,1.57	0	0,0	2.4	-1.69,6.18	2.38	-3.56,8.31	17.24	5.01,28.27	79.2	51.14,106.1
	Stroke	1.13	-0.12,2.28	0	0,0	1.3	-4.11,6.47	7.3	-0.72,15.57	12.68	0.06,25.08	24.06	-6.66,54.55

11 ER, excess rate, CI, confidence interval, CVD, cardiovascular disease, IHD, Ischemic heart disease