

**Abstract**

## **Estimation of Excess Mortality Associated with Influenzas in Korea**

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Influenza has been reported to cause significant social and economic loss due to high morbidity and high mortality among high-risk groups. Influenza is an infectious disease subject to sentinel surveillance which identifies the outbreak and epidemic patterns through relevant medical institutions and is different from mandatory surveillance which identifies all outbreaks and deaths. Therefore, as a method of confirming influenza-related deaths, the excess mortality rate is estimated mainly through time-series analysis and five such studies were conducted in Korea. This review found that number of excess deaths by influenza season in Korea was approximately 2,300 to 5,300 per year on average in one study that used data from Statistic Korea and about 532 to 913 in one study that analyzed data on patients registered with the Korean National Health Insurance Service. In all studies, the excess mortality rate was high among those over 65 years of age.

**Keywords:** Influenza, Excess mortality, Estimated number of influenza-associated death, Korea

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Table 1. Estimation of excess mortality associated with influenza in Korea

Title/Authors	Source of data	Methods	Results
Evaluation of domestic disease burden of seasonal influenza and effectiveness of influenza vaccines Heejin Jung etc. (2009)	<ul style="list-style-type: none"> <li>• Statistics Korea, cause of death (data from 1997 to 2008)</li> <li>• The Korea Disease Control and Prevention Agency (KDCA) provided influenza virus surveillance data through the Korea Influenza and Respiratory Viruses Surveillance System (KINRESS) (data from 2005 to 2008)</li> </ul>	<ul style="list-style-type: none"> <li>• Thompson model</li> <li>– Poisson regression</li> </ul>	<ul style="list-style-type: none"> <li>• National Cause of Deaths database of Statistics Korea</li> <li>– Estimated number of influenza-associated death: 2,370 per year</li> <li>– Estimated deaths from pneumonia, cardiovascular disease, and respiratory disease among the estimated number of influenza-associated deaths (1,448 per year 61.1%)</li> </ul>
Influenza-Associated Excess Mortality in South Korea Minah Park (2016)	<ul style="list-style-type: none"> <li>• Statistics Korea, cause of death (data from 2003 to 2013)</li> <li>• Provided influenza virus surveillance data through the Korea Influenza and Respiratory Viruses Surveillance System (KINRESS) (data from 2003 to 2013)</li> </ul>	<ul style="list-style-type: none"> <li>• Generalized additive model (GAM)</li> </ul>	<ul style="list-style-type: none"> <li>• National Cause of Deaths database of Statistics Korea</li> <li>– Estimated number of influenza-associated death: 2,900 per year (5.97 per 100,000 patients)</li> </ul>
Estimation of Excess Mortality Associated of Influenza Changsoo Kim (2017)	<ul style="list-style-type: none"> <li>• Statistics Korea, cause of death (data from 2013 to 2015)</li> <li>• Estimates of influenza associated deaths using National Health Insurance Corporation data (2015–2016 season)</li> <li>• The Korea Disease Control and Prevention Agency (KDCA) provided influenza virus surveillance data through the Korea Influenza and Respiratory Viruses Surveillance System (KINRESS) (data from 2013 to 2016)</li> </ul>	<ul style="list-style-type: none"> <li>• Generalized additive model (GAM)</li> </ul>	<ul style="list-style-type: none"> <li>• National Cause of Deaths database of Statistics Korea</li> <li>– Estimated number of influenza-associated death: 3,004 per year (5.5 per 100,000 population)</li> <li>• Database of National Health Insurance Service</li> <li>– Estimated number of influenza-associated death: 532 per year (62.6 per 100,000 patients)</li> </ul>
Estimation of disease burden attributable to Influenza Changsoo Kim (2018)	<ul style="list-style-type: none"> <li>• Statistics Korea, cause of death (data from 2013 to 2017)</li> <li>• Estimates of influenza associated deaths using National Health Insurance Corporation data (January 2013–May 2018)</li> <li>• The Korea Disease Control and Prevention Agency (KDCA) provided influenza virus surveillance data through the Korea Influenza and Respiratory Viruses Surveillance System (KINRESS) (data from 2013 to 2017)</li> </ul>	<ul style="list-style-type: none"> <li>• Generalized additive model (GAM)</li> </ul>	<ul style="list-style-type: none"> <li>• Database of National Health Insurance Service</li> <li>– Estimated number of influenza-associated death: 913 per year (54.2 per 100,000 patients)</li> </ul>
Estimating Influenza-associated Mortality in Korea Kwan Hong etc. (2019)	<ul style="list-style-type: none"> <li>• Statistics Korea, cause of death (data from 2009 to 2016)</li> <li>• Provided influenza virus surveillance data through the Korea Influenza and Respiratory Viruses Surveillance System (KINRESS) (data from 2009 to 2016)</li> </ul>	<ul style="list-style-type: none"> <li>• Negative binomial regression model</li> </ul>	<ul style="list-style-type: none"> <li>• National Cause of Deaths database of Statistics Korea</li> <li>– Estimated influenza-associated deaths: 5,313 per year (excess mortality rate: 10.59 per 100,000 population)</li> </ul>

Table 2. Estimated number of influenza-associated death

Season	2005–2006 season			2006–2007 season			2007–08 season			All season		
	≥65 y	<65 y	Total	≥65 y	<65 y	Total	≥65 y	<65 y	Total	≥65 y	<65 y	Total
All-cause	2,127	565	2,692	2,079	571	2,650	1,537	230	1,767	5,743	1,366	7,109
Influenza or pneumonia	129	32	161	127	29	156	80	26	106	336	87	423
Respiratory	485	72	557	614	43	657	272	45	317	1,371	160	1,531
Circulatory	758	83	841	847	126	973	529	49	578	2,134	258	2,392

Table 3. Average type and subtype-specific annual excess all-cause mortality rates in Korea, 2003–2013 (per 100,000 persons each year)

Type	0–4 years (95%CI)	5–14 years (95%CI)	15–44 years (95%CI)	45–64 years (95%CI)	≥65 years (95%CI)	All ages (95%CI)	Estimated number of deaths (per year on average)
A(sH1N1)	0.07 (−0.34,0.41)	0.06 (−0.11,0.22)	−0.03 (−0.26,0.25)	0.79 (0.28,1.36)	5.33 (0.40,9.80)	0.76 (0.15,1.44)	375
A(sH3N2)	0.12 (−0.35,0.46)	0.07 (−0.11,0.24)	0.11 (−0.18,0.38)	1.11 (0.31,1.71)	31.94 (25.43,37.06)	3.84 (3.17,4.60)	1,897
B	0.37 (0.02,0.66)	0.11 (−0.04,0.23)	0.32 (0.09,0.59)	0.83 (0.19,1.29)	10.75 (4.41,15.30)	1.45 (0.78,2.07)	716
A(pH1N1)	−0.51 (−1.03,0.03)	0.04 (−0.16,0.24)	0.05 (−0.39,0.39)	0.79 (−0.13,1.73)	2.73 (−5.02,10.15)	0.55 (−0.49,1.69)	272
All Flu	0.32 (−0.43,0.87)	0.23 (−0.12,0.52)	0.44 (−0.05,0.87)	2.73 (1.60,3.65)	46.98 (36.40,55.82)	5.97 (4.89,7.19)	2,949

Table 4. 2013–2014–2014–2015 age and gender influenza-related mortality rates and excess deaths

Division	2013–2014 season		2014–2015 season	
	Excess death (n)	Excess mortality rates (per 100,000)	Excess death (n)	Excess mortality rates (per 100,000)
Total	2,394.3	4.71 (3.53–6.55)	3,614.2	7.08 (6.19–8.17)
Gender				
Male	1,937.9	7.65 (5.00–10.95)	1,912.0	7.52 (5.26–9.36)
Female	894.7	3.53 (1.13–7.20)	1,808.1	7.11 (5.36–9.36)
Age				
0–6	1.3	0.04 (23.97–33.14)	10.0	0.31 (14.86–18.51)
7–18	18.6	0.27 (10.26–14.25)	10.6	0.16 (7.17–9.35)
19–49	30.7	0.13 (3.30–4.69)	73.3	0.31 (1.24–2.60)
50–65	340.1	3.26 (3.97–12.88)	308.3	2.87 (1.13–8.48)
≥65	1,941.9	31.27 (21.87–46.47)	3,129.9	48.38 (41.54–57.32)

Table 5. Annual influenza-related mortality estimates and excess mortality rates in Korea (2012–2013–2014–2015)

Season	Influenza exposure group			Non-exposure		Excess mortality rates (per 100,000)	Excess death (%)*
	Influenza diagnoses	Death within 30 days of influenza diagnoses	Mortality (per 100,000)	Mortality (per 100,000)	Mortality (per 100,000)		
2012–2013	310,066	306	98.7	34.5	64.2	199 (0.06)	
2013–2014	1,119,263	782	69.9	22.2	47.7	534 (0.05)	
2014–2015	1,122,510	1,211	107.9	30.8	77.1	865 (0.08)	
Per year on average	850,613	919.6	73.3	23.0	50.3	532 (0.06)	

\* Lethality (%)=(Influenza excess death/Number of influenza diagnoses)×100

Table 6. Annual influenza-related mortality estimates and excess mortality rates in Korea (2013–2014–2017–2018)

Season	Influenza exposure group			Non-exposure		Excess mortality rates (per 100,000)	Excess death (%)*
	Influenza diagnoses	Death within 30 days of influenza diagnoses	Mortality (per 100,000)	Mortality (per 100,000)	Mortality (per 100,000)		
2013–2014	1,119,391	761	67.98	20.79	47.19	528 (0.04)	
2014–2015	1,122,838	1,192	106.16	27.23	78.93	886 (0.08)	
2015–2016	1,407,973	833	59.16	14.62	44.54	627 (0.04)	
2016–2017	1,847,610	1,050	56.83	19.23	37.60	695 (0.04)	
2017–2018	2,875,601	2,752	95.88	32.31	63.57	1,828 (0.06)	
Per year on average	1,674,683	1,318	77.2	22.8	54.4	908 (0.05)	

\* Lethality (%)=(Influenza excess death/Number of influenza diagnoses)×100

Table 7. Estimated influenza-associated deaths by cause of death, the type of influenza virus, and age

Season	Influenza A virus				Influenza B virus		Influenza virus(all)		Per year on average
	H1N1		H3N2		<65 y	≥65 y	<65 y	≥65 y	All ages
	<65 y	≥65 y	<65 y	≥65 y					
<b>All-cause deaths (total)</b>	<b>1,763</b>	<b>6,061</b>	<b>2,569</b>	<b>20,127</b>	<b>2,442</b>	<b>4,226</b>	<b>6,774</b>	<b>30,414</b>	<b>5,313</b>
<b>Attributable mortality rate (%)</b>	<b>0.13</b>	<b>0.45</b>	<b>0.19</b>	<b>1.5</b>	<b>0.18</b>	<b>0.32</b>	<b>0.51</b>	<b>2.27</b>	<b>-</b>
2009-2010	860	2,684	11	68	588	873	1,459	3,625	5,084
2010-2011	375	1,256	225	1,563	12	19	612	2,839	3,451
2011-2012	1	2	813	6,183	616	1,019	1,429	7,204	8,633
2012-2013	96	359	575	4,454	40	68	711	4,881	5,592
2013-2014	126	488	397	3,182	559	1,028	1,082	4,698	5,780
2014-2015	62	254	506	4,305	290	556	859	5,115	5,974
2015-2016	243	1,018	43	372	337	663	623	2,053	2,676
<b>Respiratory or circulatory deaths (total)</b>	<b>1,233</b>	<b>3,491</b>	<b>736</b>	<b>10,883</b>	<b>552</b>	<b>2,037</b>	<b>2,521</b>	<b>16,411</b>	<b>2,705</b>
<b>Attributable mortality rate (%)</b>	<b>1.49</b>	<b>0.73</b>	<b>0.89</b>	<b>2.27</b>	<b>0.67</b>	<b>0.42</b>	<b>3.05</b>	<b>3.42</b>	<b>-</b>
2009-2010	581	1443	3	32	126	389	710	1,864	2,574
2010-2011	265	709	62	798	3	9	330	1,516	1,846
2011-2012	-	1	229	3,279	137	474	366	3,754	4,120
2012-2013	68	211	163	2,368	9	32	240	2,611	2,851
2013-2014	92	294	116	1,740	131	499	339	2,534	2,873
2014-2015	45	160	149	2,442	68	281	262	2,883	3,145
2015-2016	183	673	13	223	79	354	275	1,249	1,524
<b>Influenza or pneumonia deaths (total)</b>	<b>577</b>	<b>1,066</b>	<b>290</b>	<b>3,365</b>	<b>180</b>	<b>475</b>	<b>1,048</b>	<b>4,906</b>	<b>851</b>
<b>Attributable mortality rate (%)</b>	<b>10.05</b>	<b>1.49</b>	<b>5.05</b>	<b>4.71</b>	<b>3.14</b>	<b>0.67</b>	<b>18.23</b>	<b>6.87</b>	<b>-</b>
2009-2010	121	328	-	7	16	63	137	398	25
2010-2011	76	189	14	189	-	2	91	380	535
2011-2012	-	-	60	908	25	98	85	1,007	471
2012-2013	27	74	53	719	2	7	82	800	1,092
2013-2014	50	112	53	580	39	125	142	818	882
2014-2015	36	69	93	876	30	78	159	1,023	960
2015-2016	267	293	16	85	68	103	352	481	1,182