

Comparison of the reproductive numbers (R_0) of Middle East respiratory syndrome (MERS) coronavirus nosocomial outbreaks in Saudi Arabia and Korea

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When novel infectious diseases emerge, it is important to quantify the actual outbreaks. The mathematical models can provide the gravity of a disease, as well as its potential for ongoing transmission by calculating the basic reproduction number (R_0). R_0 has been extensively used to assess transmissibility of pathogens, severity of outbreaks, and epidemiological control.

The 2015 MERS outbreak in South Korea was associated with hospital-acquired infections. Since Korean government considered that R_0 is less than 1, they decided the initial criteria for quarantine was limited to the close contacts which was defined as the people who stayed within two meters during one hour or more with the MERS cases.

This study focuses on estimation of R_0 for MERS in order to explain the large-scale outbreaks occurred in KSA and South Korea. We compared the R_0 s of MERS for nosocomial outbreaks by area or hospitals through "incidence decay with exponential adjustment (IDEA)" model.

Data Source

- The incidence data of Kingdom of Saudi Arabia (KSA) was from the KSA Ministry of Health and WHO reports.
- For Korean incidence data, we used the reported data from the KCDC (Korea Center for Disease Control and Prevention).

IDEA Model

$$I(t) = \left[\frac{R_0}{(1+d)^t} \right]^t$$

- R_0 : the basic reproductive number
- I : incidence cases in a generation
- d : discounting factor that causes epidemic growth to decay
- t : epidemic generation

Model Fitting

- Models were fit to overall cumulative incidence data and to regional data.
- Counts were aggregated by generation.
- Fits performed with the least-squared data fitting method in the Matlab software.

Results

Table1. Characteristics of selected outbreaks of Saudi Arabia and South Korea

		Saudi Arabia		South Korea		
		Jeddah	Riyadh	Total case	Hospital Pyeongtaek	Hospital Samsung
Outbreak	Onset date	28 Mar 2014	20 Mar 2014	11 May 2015	11 May 2015	21 May 2015
	Duration (day)	67	71	55	23	45
	No. of case	180	142	186	36	91
Exposure	Hospital	79	72	180	36	88
	Household			4	0	3
	Camel	1	3	0	0	0
	Unknown	100	67	2	0	0
Status of case	Health care worker	40	8	39	3	15
	Patient			82	20	36
	Family or visitor			63	13	40
	Unknown	140	138	2	0	0
Missing	Onset date	106	76	8	1	6
	Hospitalized date	88	56	0	0	0
	Reported date	0	0	0	0	0

Fig 1. Epidemic curves by selected outbreaks of Saudi Arabia and South Korea

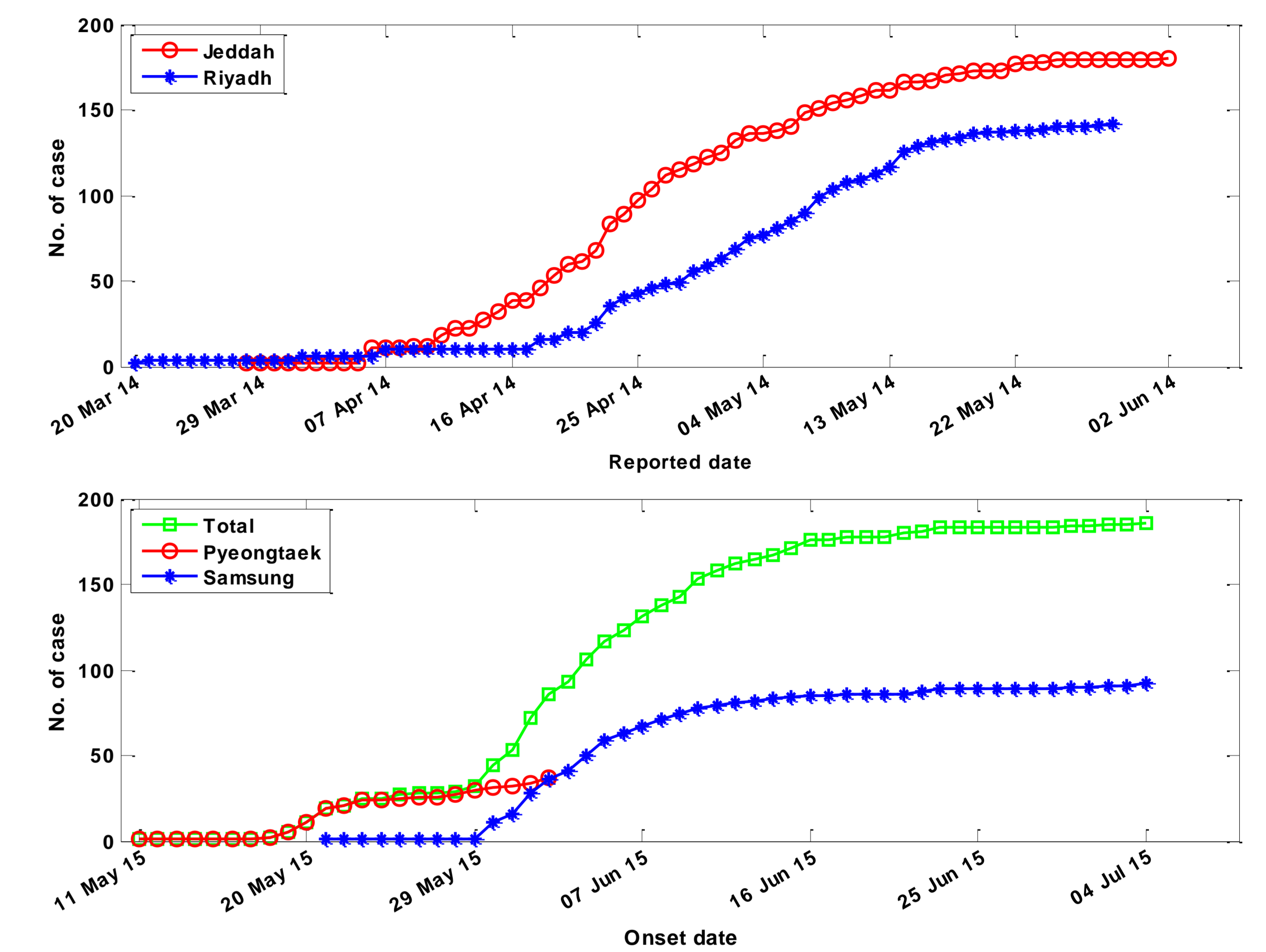
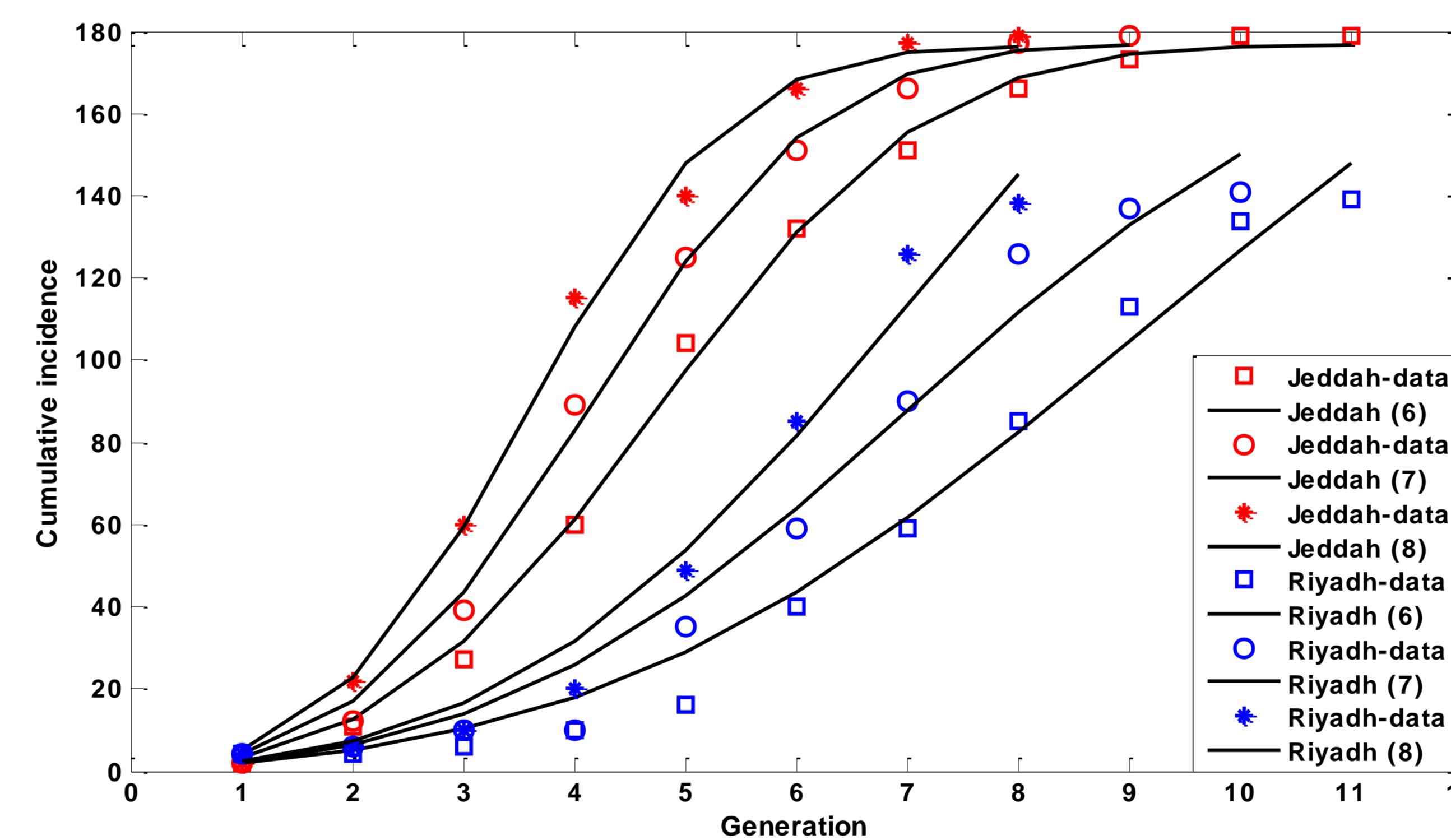
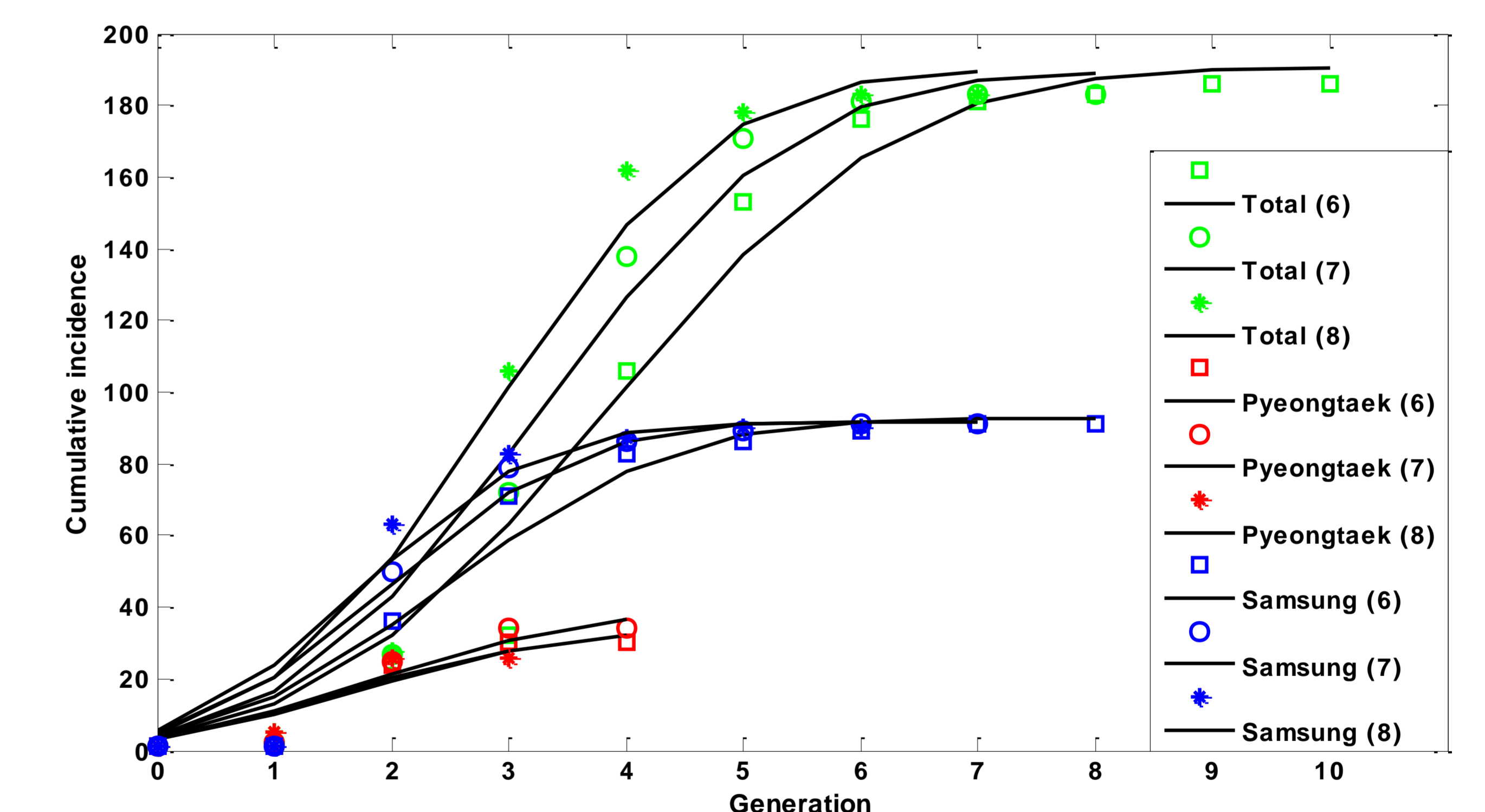


Fig2. Best fitted R_0 by serial intervals of MERS outbreak in Jeddah and Riyadh in KSA, 2014 using IDEA model



Serial Interval	R_0		d		Resnorm	
	Jeddah	Riyadh	Jeddah	Riyadh	Jeddah	Riyadh
6	3.9463	1.9168	0.1401	0.0346	112.1495	489.3703
7	5.0505	2.3247	0.1916	0.0575	118.3074	680.2378
8	6.6806	2.5252	0.2618	0.0637	137.3537	426.9742

Fig3. Best fitted R_0 by serial intervals of MERS outbreak in South Korea, 2015 using IDEA model



Serial Interval	R_0			d			Resnorm		
	Total	Hospital Pyeongtaek	Hospital Samsung	Total	Hospital Pyeongtaek	Hospital Samsung	Total	Hospital Pyeongtaek	Hospital Samsung
6	3.9555	4.0426	5.0000	0.1379	0.2432	0.2263	1577	119.790	396.455
7	4.9125	4.2315	6.8006	0.1822	0.2456	0.3190	888.7	113.133	462.470
8	5.9531	4.3935	8.1151	0.2270	0.2746	0.3812	1256.3	75.486	682.259

Discussion

- The estimated R_0 is basic characteristics and important to decide the countermeasure efforts. However, for the new emerging infectious diseases, the epidemiology of the disease were not known, it is hard to build mathematical modelling. To overcome this difficult, we used the IDEA model.
- The estimated R_0 s for Riyadh and Jeddah in KSA were from 1.9 to 6.9 while the R_0 s for the outbreak of South Korea were from 3.9 to 8.0.
- R_0 for MERS-CoV is greater than what was reported to be lower than 1 for the cases of the nosocomial outbreaks occurred in KSA and Korea. This demonstrates that more active and extensive measures are needed when dealing with nosocomial infections of MERS.