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Spatial Covariate Adjusted Survival Rates for Middle East Respiratory Syndrome (Mers) Coronavirus in the Arabian Peninsula

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Introduction

The frequent outbreaks of novel or emerging infectious diseases are alarming. There is a need for urgent and appropriate intervention that can be adapted quickly for such diseases. Middle East respiratory syndrome coronavirus (MERS-CoV) previously known as novel CoV is a viral infection that causes severe acute respiratory illness. MERS-CoV is a respiratory pathogen and contagious that is contracted via close contact with infected subject. It appears to have been transmitted from camels to humans, recent studies have revealed an association among the virus found in humans and that found in camels (Drosten, et al., 2014). The epidemic that started in 2012 in the Kingdom of Saudi Arabia has spread to many countries, mostly in the Middle East and North Africa, and more recently South Korea. The new epidemic started when the virus crossed from an infected individual who had recently traveled to the Middle East and subsequently began spreading between people via direct contact while in some cases the infection crossed from animal to human. This has exposed the general populace and especially the healthcare workers to greater risk. Similar to the reaction during other infection outbreaks, such as SARS and Ebola virus, many countries have issued travel restrictions and advisories to the affected countries because of fear of international spread of the disease. The rate at which the outbreak is evolving cannot be overemphasized and the geographical extension of its spread is widening. Neighborhoods constitute a key determinant of socioeconomic disparities and health habits, and therefore there is a high risk that people at geographical proximity to the infection are particularly vulnerable. Additionally, people with preexisting chronic medical conditions are more prone to being infected by the illness or developing a severe case resulting in fatality (Assiri, et al., 2013). Strong links between healthcare facilities and the outbreak of the disease has been found in Jeddah, where the majority of patients were in contact with other patients or health care facilities (Oboho, et al., 2015). Elsewhere, the transmission of MERS-CoV in household contacts revealed that

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an outcome of approximately 5% as the rate of secondary transmission occurred at home (Assiri, et al., 2013). In spite of the many research conducted on MERS-CoV, very few have investigated the effect of ecological factors on the transmission of the disease. Moreover, very little is known on the possibility of airborne transmission of the virus and discussion is still on going on this issue. Airborne transmission of the pathogen may also occur through dust and movement of people, equipment and animals within infected countries which may contribute to the spread of the virus. Additionally, the effect of alternating temperature highs and lows may imply seasonality that could alter the transmission and survivability of the virus. Objectives During infectious disease outbreaks, transmission of disease may form networks of infected individuals because of the way virus crossed from infected individual to susceptible individual. See figure 1a for a subset of the infection network for MERS disease used in this study. The infected individuals may form network of individuals connected by source of infection (contact) as direct or indirection connection. The study intends to (1) explore and investigate the relationship between the intensity of the disease in a given region and environmental variables, (2) We sought to evaluate the risk factors of and trends in mortality as a result of MERS-CoV infection in a large cohort of patients between June 6, 2012 and May 19, 2015. Use covariate adjustment to correctly assess the disease-risk factor associated with the survival outcome, (3) It also aims to understand the dynamic pattern of the disease over different temporal and spatial scales. A functional spatial time series method of estimating the death rate in the outbreaks will be formulated. Spatial time series analysis of disease outbreaks are versatile tools for studying and understanding transmission and spread of a disease and may be useful in the different frontiers of its upsurge and in the possibility of its containment or eradication. And lastly, (3) a flexible dependence model that reflect the relationship among infected individuals in the same network.

Figure 1: (Top) Network for subset of the MERS data. The numbers represent the identification number of the patient while the arrow represents the infection direction. (Bottom) Showing the patients that were infected by patient 27.

Figure 2: Number of patients infected by each main contact (patient ID). Preliminary Exploratory Analysis This study is based on a retrospective analysis of the Middle East respiratory syndrome coronavirus (MERS-CoV) outbreak in the Arabian Peninsula between June 6, 2012 and May 19, 2015.

Table 1 presents the summary of data used in this study. Of the 958 cases recorded during the study period more than 90% (866) of the disease incidence occurred in the Kingdom of Saudi Arabia while Kuwait has the least incidence of 3. Seventeen percent of those infected with MERS disease were heath care worker. The fatality for the disease is about 0.35 among the total population. The mean age of the infected persons was 50.22±18.37 years, with large percentage (55%) reported that they had some kind of comorbidity. Spatial analyses of disease outbreaks are versatile tools for studying and understanding transmission and spread of a disease.

Figure 3 shows the spread of MERS disease across the Arabian Peninsula within the study period. Majority of the disease incidence occurred in KSA and closed countries.

Table 1. Summary of the MERS data Country No. of Patients No. of Male/female No. with comorbidity Age at incidence % of HCW % fatal Mean/median mean SD KSA 866 565/284 469 49.66/50 49.66±18.54 153 302 UAE 70 50/18 49 54/56 54±15.33 9 30 Qatar 12 9/3 5 59.1/58 59.1±15.99 1 3 Kuwait 3 1/2 3 54/43 54±27.22 0 1 Oman 7 7/0 2 56.28/60 56.28±17.54 1 3 Total 958 632/307 528 50.22/50.5 50.22±18.37 164 339