Research Statement
Mohammad Nayeem Hasan

I am a PhD candidate in the program in the **Department of Agricultural Economics, Sociology, and Education** at **The Pennsylvania State University.** In my role within the **research team as a statistician**, engaging with various disease studies using a statistical approach has nurtured a compassionate disposition toward humanity. Consequently, my primary research interests orbit around infectious, and non-communicable diseases, childhood diseases, early childhood development, maternal health, indoor environment, groundwater quality, and meteorological factors. My research statement is in two parts; the first part is about my work on infectious disease, while the second part is about my other research work.

Current research work (Dengue):

Related to the ongoing Dengue outbreak in Bangladesh, the 2022 outbreak is characterized by late onset of dengue cases with unusually higher deaths in colder months, that is, October–December. In this study, we presented possible hypotheses and explanations for this late resurgence of dengue cases. As a result, we found that, first, in 2022, the rainfall started late in the season. Compared to the monthly average rainfall for September and October between 2003 and 2021, there was 137 mm of additional monthly rainfall recorded in September and October 2022. Furthermore, the year 2022 was relatively warmer with a 0.71°C increased temperature than the mean annual temperature of the past 20 years. Second, a new dengue virus serotype, DENV-4, had recently reintroduced/reappeared in 2022 and became the dominant serotype in the country for a large naïve population. Third, the post-pandemic return of normalcy after 2 years of nonpharmaceutical social measures facilitates extra mosquito breeding habitats, especially in construction sites. Community engagement and regular monitoring and destruction of Aedes mosquitoes' habitats should be prioritized to control dengue virus outbreaks in Bangladesh (1). In another short communication, we investigated that, the dengue virus vector, mosquitoes, found a high prevalence of infection due to the weather's favorable conditions for breeding in June and July. While there is presently no particular vaccination for dengue infection, awareness of its epidemiology, pathogenesis, signs, and symptoms may aid in the development of improved diagnostic and treatment strategies (2). Again, speculation about DENV outbreak characteristics, trends, and that correlation with meteorological factors, we used five-time series models to observe the trend and forecast Dengue cases. The Spearman's rank correlation coefficient between climatic variables and Dengue incidence indicated that no substantial relationship exists between daily Dengue cases and wind speed, temperature, and surface pressure. Still, a significant relationship exists between daily Dengue cases and dew point, relative humidity, and rainfall. Using the ARIMAX and GA models, the relationship for Dengue cases with wind speed. A similar negative relation between Dengue cases and wind speed was also determined in the GLM model. Dew point and surface pressure also represented a negative correlation in both ARIMAX and GA models, respectively, but the GLM model showed a positive association. Additionally, temperature and relative humidity showed a positive correlation with Dengue cases. In contrast, both temperature and relative humidity showed a negative relation with Dengue cases in the GLM model. In the Poisson regression model, windspeed has a substantial significant negative connection with Dengue cases in all seasons. Temperature and rainfall are significantly and positively associated with Dengue cases in all seasons (3).

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Future work (Dengue):

In another objective, we are trying to compare the dengue virus (DENV) infection, deaths, case-fatality ratio, as well as meteorological parameters between the first and the recent decade (2000-2010 vs. 2011-2022) and to understand the trends, seasonality, and impact of change of temperature and rainfall pattern on transmission dynamics of Dengue in Bangladesh. Mann-Kendall and Sen's slop tests were used for trends and variations and fitted a time series Poisson regression model to identify the impact of meteorological parameters on the incidence of dengue cases. A forecast of dengue cases was performed using an autoregressive integrated moving average model. Over the past 22 years, a total of 244,246 dengue cases were reported including 849 deaths (Case fatality ratio [CFR] =0.34%). The mean annual number of dengue cases increased eight-fold during the second decade, with 2216 cases during 2000-2011 vs. 18,321 during 2012-2022. Monthly mean temperature (Incidence risk ratio [IRR]: 1.26), first-lagged rainfall (IRR: 1.08), and second-lagged rainfall (IRR: 1.17) were significantly associated with monthly dengue incidence (4). In addition, we tried to find out the relation of dengue with water sanitation and hygiene (WASH) facilities, in another study, socio-economic, clinical features, and symptoms of dengue patients were also investigated. In addition, we are trying to show the trend of all types of water-borne diseases among Rohingya Refugees in Bangladesh.

Current Research Work (COVID-19):

Research we conducted to determine whether or not there is a connection between the presence of fine particulate matter (PM2.5) and meteorological conditions and COVID-19 infection rates in Bangkok, Thailand. The study employs a statistical method called the Generalized Additive Model (GAM) to find a positive and non-linear association between relative humidity (RH), absolute humidity (AH), and rainfall (R), and the number of verified COVID-19 cases. The impacts of the seasons (especially summer) and rainfall on the trajectory of COVID-19 cases were also highlighted, with an adjusted R-square of 0.852 and a deviance explained of 85.60%, both of which were statistically significant ($p < 0.05$) (5). A similar study was also conducted in Bangladesh when vaccination started in Bangladesh to determine the potential determinants such as meteorological factors and their roles, before and after vaccination, and we found a significant difference (6). In another study, we investigated the global reported cumulative case–fatality ratios (rCFRs) and excess mortality rates of the 20 countries with the highest coronavirus disease 2019 (COVID-19) vaccination rates, the rest of the world and Sub-Saharan Africa (SSA) compared before and after the commencement of vaccination programs. In conclusion, we stated that Vaccine equity and faster roll-out across the world are critically important in reducing COVID-19 transmission and CFR (7). In addition, we aimed to assess the person's knowledge, attitude, and practices (KAP) toward the COVID-19 epidemic in Southeast and South Asia by applying the mixed study design (cross-sectional and systematic review) in a study (8). In addition, we also found, the Global case-fatality rate of COVID-19 has been declining disproportionately between top vaccinated countries and the rest of the world (9) and The Global Case-Fatality Rate of COVID-19 Has Been Declining Since May 2020 (10). Lastly, we proved that, the Global Health Security index and Joint External Evaluation score for health preparedness are not correlated with countries' COVID-19 detection response time and mortality outcome (11).

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Future research work (COVID-19):

We are trying to research a continental analysis comparing vaccine distribution and case-fatality ratio of COVID-19 pre- and post-implementation of vaccine programs. To conduct this research, we planned to use the regressive Integrated Moving Average (ARIMA) model to show trends and forecast COVID cases and the Generalized linear Mixed (GLM) model to investigate the association for each continental country.

Current research work (Other):

In a recent study, to investigate the status of early childhood development (ECD) and its associated factors. Additionally, aimed to compare the changes of significantly associated factors using two multiple indicator cluster surveys (MICS) in Bangladesh. We used bivariable analysis and crude and adjusted multivariable logistic models to assess the ECD status and its associated factors. In summary, our study shows that the overall ECD status improved between MICS 2012 and MICS 2019. Important factors influence ECD status, including early childhood education programs, families' possession of children's books, mothers' educational level, and wealth index (12). In a study, we conducted a systematic review and meta-analysis to determine the overall case fatality rate (CFR) of MPXD worldwide during 1970-2022 (13). Apart from that, we worked with The Prevalence of Active Commuting to School and the Factors Influencing Mode Choice: A Study of University Students in a Secondary City of Bangladesh ((14), an association of household fuel with acute respiratory infection (ARI) under-five years children in Bangladesh ((15), and Knowledge of HIV/AIDS among married women in Bangladesh: analysis of three consecutive multiple indicator cluster surveys (MICS) (16).

Future research (Other):

In a study, we sought to investigate the trends and predict the human rabies cases as related to the use of MDV and human anti-rabies vaccine (ARV) in Bangladesh. Furthermore, we have compared the phylogenetic analyses of rabies virus sequences reported in Bangladesh and other South Asian countries extracted from GenBank. We interpreted that, Bangladesh's One Health approach demonstrated that an increase in MDV and ARV resulted in a decline in the relative risk of human rabies cases, indicating that eliminating dog-mediated human rabies could be achievable (17). In addition, we also preparing a manuscript with non-communicable diseases with the data of South Asian countries. Our initial aims are to calculate country-specific prevalence and pooled prevalence, compare the results across the continents, find out the most vulnerable areas, and identify the factors that commonly affect NCDs across the countries. In addition, we also working with, the early childhood development index (ECDI), health care utilization among women, global prevalence and factors of exclusive breastfeeding, neonatal tetanus and their factors, factors associated with E-coli and diarrhea in Bangladesh, patient satisfaction, and quality of life (QoL) of Rohingya Refugees in Bangladesh. In addition, we also investigate the health-related factors behind the dropout of children from school.

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