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IMPACT OF MEDIA AWARENESS AND USE OF FACE-MASKS ON INFECTIOUS RESPIRATORY DISEASE

HENRY M. WANJALA[1,*], MARK O. OKONGO[2], AND JIMRISE O. OCHWACH[2]

ABSTRACT. Infectious respiratory diseases have been a threat to our lives and livelihoods. Communities with a higher population density ultimately are at a higher risk of a rapid spread of infectious disease once they occur. Mathematical models have extensively been used to analyse the impact of several mitigation measures to the transmission of infectious diseases. The focus of this study is to determine the impact of media awareness, use of face-masks alongside quarantine and isolation on the transmission dynamics of a respiratory infection where there is no available vaccination or treatment plan. The model is based on a system of deterministic ordinary differential equations (ODE's). By the use of the next generation matrix (NGM), the basic reproduction is determined. The local stability analysis analysis of the disease free equilibrium (DFE) is obtained by the trace-determinant approach while it's global stability was determined by the use of the Lyapunov-Krasovskii method. It was established that the local DFE was asymptotically stable while it was unstable globally implying that with application of this intended strategies, the transmission of the disease could be lowered but not eradicated. The importance of media awareness to any campaign towards reduction of transmission is paramount. Effort should be geared towards the public having correct information on a given disease. The impact of face mask is dependent on the efficacy of the face - mask and its compliant and consistent use, these two factors are multiplicative. Numerical simulations were done by the use of Python software and it was established that if quarantine rate and the isolation rate was to be maximised then the disease would be curtailed. The results of this study gives valuable information on the intervention strategies to be applied by the public heath officials.

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1. INTRODUCTION

Public health goals in any respiratory infectious disease is to lower the infection rate and manage it's burden on the health facilities and personnel (Collinson *et al.,* 2015). Mass media has been widely used to disseminate necessary information on the public health measures to be undertaken with major success (Wakefield *et al.*, 2011). Developing countries have limited medical facilities and personnel and therefore awareness to a disease is a strategy employed to minimise the health burden (Misra *et al.,* 2018). Funk *et al.* (2009), noted that there's a behavioural change in response to a disease outbreak which could be as a result of media awareness. Individual and community response to the threat of an infectious disease is due to it's perception by the public arising from the media campaign (Liu *et al.,* 2007). Media coverage and extensive flow of information about the epidemic has a great impact on the public to make change on their behaviour

[1]CHUKA UNIVERSITY, KENYA

[2]DEPARTMENT OF PHYSICAL SCIENCES, CHUKA UNIVERSITY, P.O. BOX 109-60400, KENYA
E-mail addresses: teomat240@gmail.com, markokongo@yahoo.com, ojimrise09@gmail.com.
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*Corresponding author.

to avoid infecting others or being infected (Wang & Xiao, 2014). In the initial stages of an epidemic, the infectious disease might not have been identified or it's treatment plan and vaccine not developed, these, informs the need of effective media coverage of the diseases so as to reduce infection and enhance the application of Non-Pharmaceutical Interventions (NPI's) (Sun *et al.,* 2011; Sahu and Dhar, 2015).

Mathematical models quantitatively explain the epidemiological problem through a written down set of equations that represent the actual progression and the solution to the parameters (Panovska-Griffiths, 2020). Several mathematical models have been developed to assess the impact of media awareness on the transmission of diseases. Feng *et al.* (2020), proposed a deterministic model on the impact of media awareness on the susceptible, who take precautionary measures to minimise COVID-19 transmission. It reported that media is an important tool in the prevention of the spread of COVID-19. Kobe, (2020) on his study on the impact of media awareness on COVID-19 reported that programs to sensitise the public are key in the reduction of transmission. A deterministic model analysing the impact of media awareness was developed by Koutou *et al.* (2020). It reported that media awareness alongside NPI's will be able to curtail the spread of COVID-19.

The impact of the use of face-masks on the spread of infectious respiratory diseases has been studied. Srivastav *et al.* (2020) proposed a mathematical model focusing on the use of face-masks on COVID-19 transmission prevention. It reported that the use of face-masks may significantly lower the spread of COVID-19, however, it should be complemented with other strategies. this conclusion was also established by the study of Iboi *et al.* (2020), who reported that for effective control of COVID-19 transmission then, the consistent use of face-mask should be above 80% which is unrealistically tenable. Eikenberry *et al.* (2020), reported that face masks are necessary in mitigating the spread of COVID-19 and that the consistent use of the face-mask and the efficacy of the face-mask are multiplicative. Morciglio *et al.*(2020), further reiterated that the use of face-masks was important in the reduction of the transmission of COVID-19 and suggested that the efficacy of the face-mask is key in eliminating the transmission.

Several shelter in place strategies have been studied to determine their impact on the spread of a respiratory infectious disease. Zeb *et al.* (2020), proposed that isolation should be applied to all the infected population to manage transmission, though the strategy is unfeasible. Ahmed *et al.* (2021) expounded on the use of quarantine as a strategy to control the spread of COVID-19. It reported that quarantine alongside effective testing will be able to curtail the transmission. Olaniyi *et al.* (2020) suggested that while isolation would be remarkable in lowering the transmission rate, it was necessary to increase the recovery rate while minimising the transmission rate.

The aim of this study is to analyse the impact of media awareness, use of face-masks alongside quarantine and isolation in lowering the transmission of respiratory infectious disease.

2. Model Formulation and Development

The population is split into seven mutually exclusive compartments of susceptible (S(t)), exposed (E(t)), quarantine (Q(t)), asymptomatic (A(t)), symptomatic (I(t)), isolated (J(t)) and the recovered (R(t)). The entry into the population is at the rate Λ. The media efficiency rate is, B, which encourages the susceptibles to undertake precautionary measures against contracting the disease. The population wears face-masks of an efficacy ϵ_m with a fraction c_m wearing the mask consistently and correctly. The susceptible become exposed at the rate λ with some being quarantined at the rate, q, for a quarantine period, z. A fraction η become asymptomatic after the latency period ω, while the rest (1 - η) are symptomatic. After the quarantine period, z, a fraction p, are confirmed infected and thus isolated, while, the rest, (1-p) return to the susceptible class.

The symptomatic are isolated at the rate γ. The asymptomatic recover at the rate ρ_A, while ρ_J is the recovery rate of those isolated. There's a natural death rate μ across the compartments. The model flow chart is shown in figure 1.

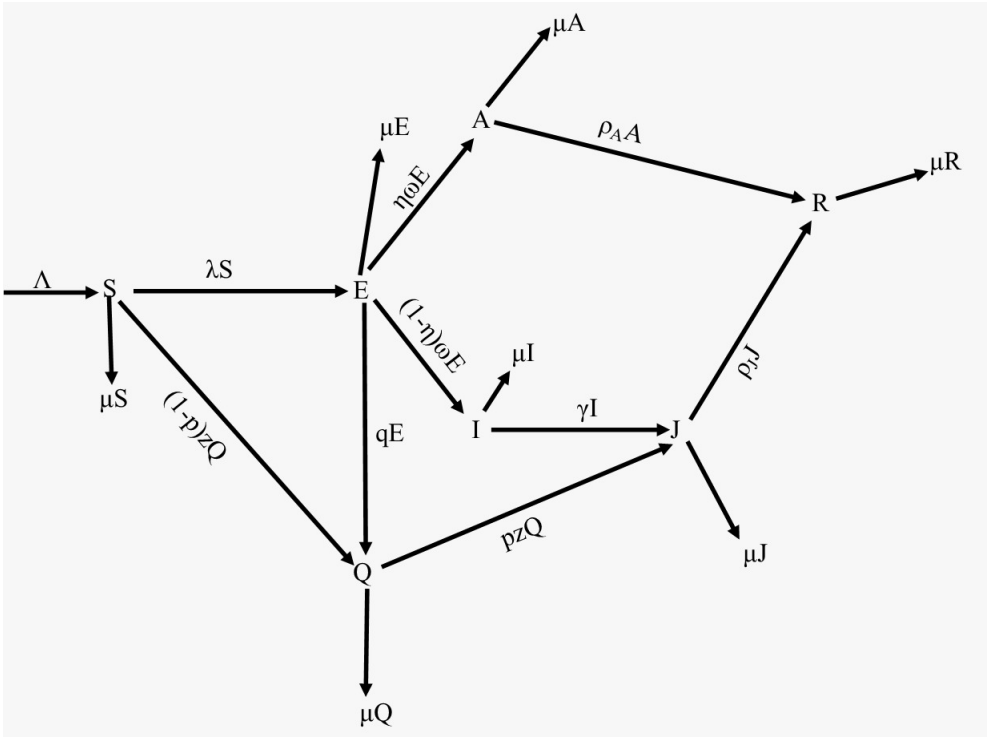

FIGURE 1. Model Flow Chart

The model equations are represented in equations 2.1

$$
\begin{aligned}
\frac{dS}{dt} &= \Lambda + (1-p)zQ - (\lambda+\mu)S \\
\frac{dE}{dt} &= \lambda S - (\mu+\omega+q)E \\
\frac{dQ}{dt} &= qE - (\mu+z)Q \\
\frac{dA}{dt} &= \eta\omega E - (\mu+\rho_A)A \\
\frac{dI}{dt} &= (1-\eta)\omega E - (\mu+\gamma)I \\
\frac{dJ}{dt} &= \gamma I_S + pzQ - (\mu+\rho_J)J \\
\frac{dR}{dt} &= \rho_A A + \rho_J J - \mu R
\end{aligned}
\tag{2.1}
$$

The force of infection, λ is given by equation 2.2:

$$\lambda = \beta((1-\epsilon_m c_m)(1-B)(A+\epsilon_1 I+\epsilon_2 J))/N \tag{2.2}$$

The model parameters and the parameter values are shown in the table 1 below

TABLE 1. Parameter values of SARS-COV-2

Symbol	Parameter	Value	Source
Λ	Recruitment rate by birth	0.00018 days^{-1}	Mwalili *et.al.*, (2020)
μ	Natural death rate	4.563 $\times 10^{-5}$ days^{-1}	Mwalili *et.al.*, (2020)
p	Fraction of those isolated after quarantine	0.8	Assumed
ρ_A	Rate of recovery of asymptomatic patients	1/7	Tang *et.al.*, (2020)
ρ_J	Rate of recovery of isolated patients	1/28	Balike, (2021)
ω	Latency period	1/14	Yang *et.al.*, (2020)
γ	rate of isolation of symptomatic patients	0.04	Assumed
β	Effective contact rate	0.5 days^{-1}	Wangari *et.al.*, (2021)
z	Quarantine period	1/14 days	Balike, (2021)
c_m	fraction of population wearing face masks correctly and consistently	0.1	Iboi *et.al.*, (2020)
ϵ_m	Efficacy of face mask	0.5	Iboi *et.al.*, (2020)
ϵ_1	Infections by the Exposed	0.48	Wangari *et.al.*, (2021)
ϵ_2	infections by the Isolated	0.48	Wangari *et.al.*, (2021)
η	Fraction of those Asymptomatic but Infectious	0.7	Mwalili *et.al.*, (2020)
q	Rate of transfer of E to Q	2.0138 $\times 10^{-4}$	Ahmed *et.al.*, (2021)
B	Efficiency of Media awareness program	0.5	Assumed

3. MODEL ANALYSIS

3.1. **Positivity of the Solution.** The model system (2.1) deals with living organisms and thus the associated state variables are non-negative for all the time $t > 0$. Thus, the solutions to model (2.1) with initial data is positive for all time t > 0.

Theorem 3.1. *The region* $\mathcal{D} = \{(S(t), E(t), A(t), I(t), Q(t), J(t), R(t)) \in \mathfrak{R}^9_+ : N(t) \leq \frac{\Lambda}{\mu}\}$ *is positively invariant and attracting with respect to model 2.1.*

Proof. Solving the first equation of (2.1) for S(t) at time, t > 0, it is obtained that:

$$\begin{aligned}
\frac{dS}{dt} &= \Lambda + (1-p)zQ - (\lambda + \mu)S \\
\frac{dS}{dt} &\geq -(\lambda + \mu)S \\
\int \frac{dS}{S} &\geq -\int (\lambda + \mu)dt \\
\int_{S(0)}^{S} \frac{dS}{S} &\geq -\int (\lambda + \mu)dt
\end{aligned}$$

$$InS - InS(0) \geq -\int (\lambda + \mu)dt$$
$$In\frac{S}{S(0)} \geq -\int (\lambda + \mu)dt$$
$$\frac{S}{S(0)} \geq e^{-\int(\lambda+\mu)dt}$$
$$S \geq S(0)e^{-\int(\lambda+\mu)dt}$$

Clearly, S(0) $e^{-\int(\lambda+\mu)dt}$ is a non- negative function of t, thus S (t) stays positive.
Similar proofs can be established for the positivity of other variables using the corresponding equation of the system. This shows that the solutions of the system 2.1 with non-negative initial conditions such that , $E(t) > 0, A(t) > 0, I(t) > 0, Q(t) > 0, J(t) > 0$ and $R(t) > 0$ will remain non-negative for all time $t \geq 0$.
□

3.2. **Invariant Region.**

Theorem 3.2. *There exists a domain $\mathcal{H}$ in which the solution set S(t), E(t), A(t), I(t), Q(t), J(t) and R(t) of model equation (2.1) is positively invariant.*

Proof. The total human population can be determined by,

$$N(t) = S(t) + E(t) + A(t) + I(t) + Q(t) + J(t) + R(t) \tag{3.1}$$

Then the time derivatives of N(t) along the solutions of model system (2.1) gives the following:

$$\frac{dN}{dt} = \Lambda - \mu N \tag{3.2}$$

In the absence of the disease, in the population,

$$\frac{dN}{dt} \leq \Lambda - \mu N \implies N(t) = \frac{\Lambda}{\mu} + (N(0) - \frac{\Lambda}{\mu})e^{-\mu t} \tag{3.3}$$

$N(0) = S(0) + E(0) + A(0) + S(0) + Q(0) + J(0) + R(0)$,
Thus if, N(0) $\leq \frac{\Lambda}{\mu}$, then, N(t) $\leq \frac{\Lambda}{\mu}$ as t $\to \infty$. Therefore, $\mathcal{H} = \{(S(t)$, E(t), IA(t), I(t), Q(t), J(t), $R(t)) \in \mathfrak{R}^9_+ : N(t) \leq \frac{\Lambda}{\mu}\}$ is the feasible solution of model equation (2.1) which implies the total number of human population is positively invariant. Therefore, the model is biologically meaningful and mathematically well posed in the region $\mathcal{H}$
□

3.3. **Basic Reproduction Number.** The basic reproduction number (R_0) is the measure of the new infections by the index patient in a purely susceptible population. The basic reproduction equation is obtained by the use of the next generation matrix (NGM). The Jacobian matrix derived from the model equations is used to determine the reproduction number.

Theorem 3.3. *The basic reproduction number ($\mathcal{R}_o$) for the epidemiological model 2.1 is given by equation 3.4:*

$$\mathcal{R}_0 = \frac{m\beta_0\eta\omega}{k_1k_3} + \frac{m\beta_0(1-\eta)\omega\epsilon_1}{k_1k_4} + \frac{m\beta_0\epsilon_2pzq}{k_1k_2k_5} \tag{3.4}$$

where:
m=$\frac{\Lambda}{\mu}$,

and,
$k_1 = \mu, k_2 = \mu + z, k_3 = \mu + \rho_A, k_4 = \mu + \gamma, k_5 = \mu + \rho_J, \beta_0 = \beta(1 - \epsilon_m c_m)(1 - B)$

Proof. The basic reproduction number is the spectral radius of the matrix FV^{-1}. By taking the infectious subsystem of the model system (2.1), we determine the transmission matrix (F) and the transition matrix (V) as shown in equations 3.5 and 3.6:

$$F = \begin{pmatrix} 0 & 0 & m\beta_0 & m\beta_0\epsilon_1 & m\beta_0\epsilon_2 \\ 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 \end{pmatrix} \tag{3.5}$$

and

$$\mathcal{V} = \begin{pmatrix} -k_1 & 0 & 0 & 0 & 0 \\ q & -k_2 & 0 & 0 & 0 \\ \eta\omega & 0 & -k_3 & 0 & 0 \\ (1-\eta)\omega & 0 & 0 & -k_4 & 0 \\ 0 & pz & 0 & \gamma & -k_5 \end{pmatrix} \tag{3.6}$$

and

$$FV^{-1} = \begin{pmatrix} a & -\frac{m\beta_0\epsilon_2 pz}{k_2 k_5} & -\frac{\beta_0}{k_3} & -\frac{m\beta_0\epsilon_1}{k_4} & -\frac{m\beta_0\epsilon_2}{k_5} \\ 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 \end{pmatrix} \tag{3.7}$$

Where, $a = \frac{m\beta_0\eta\omega}{k_1 k_3} + \frac{m\beta_0(1-\eta)\omega\epsilon_1}{k_1 k_4} + \frac{m\beta_0\epsilon_2 pzq}{k_1 k_2 k_5}$
and
m=$\frac{\Lambda}{\mu}$, $k_1 = \mu, k_2 = \mu + z, k_3 = \mu + \rho_A, k_4 = \mu + \gamma, k_5 = \mu + \rho_J, \beta_0 = \beta(1 - \epsilon_m c_m)(1 - B)$

Thus, the basic reproduction equation is given in equation 3.8

$$\mathcal{R}_0 = \frac{m\beta_0\eta\omega}{k_1 k_3} + \frac{m\beta_0(1-\eta)\omega\epsilon_1}{k_1 k_4} + \frac{m\beta_0\epsilon_2 pzq}{k_1 k_2 k_5} \tag{3.8}$$

□

3.4. **Equilibrium Analysis.**

3.4.1. *Disease Free Equilibrium Point.* The DFE of the system 2.1 is obtained by setting all the infectious classes to zero, so as to obtain equation 3.11:

$$\begin{aligned} \mathcal{E}_\prime &= (S^0, E^0, Q^0, A^0, I^0, J^0, R^0) \\ \mathcal{E}_\prime &= (\frac{\Lambda}{\mu}, 0, 0, 0, 0, 0, 0) \end{aligned} \tag{3.9}$$

3.4.2. *Stability Analysis of the Disease Free Equilibrium Point.* Connelly (2023) provided a theorem to determine the local stability analysis of a system of ODE's by the numerical analysis.

Theorem 3.4. *Assume the first order partial derivatives of f and g are continuous in some open set containing the equilibrium point ($\hat{x}$,$\hat{y}$). Then, the equilibrium is locally asymptotically stable if,*

(1) *Tr (J) < 0, and*

(2) *det (J) > 0*

where, J is the Jacobian matrix evaluated at the equilibrium. In addition, the equilibrium is unstable if either Tr(J) > 0 or det(J) < 0.

Computing the Jacobian matrix of equation (2.1) at DFE, it yields equation 3.10:

$$\mathcal{J}_f = \begin{pmatrix} k_1 & 0 & (1-p)z & -m\beta_0 & -\epsilon_1 m\beta_0 & -\epsilon_2 m\beta_0 & 0 \\ 0 & k_2+Q & 0 & m\beta_0 & \epsilon_1 m\beta_0 & -\epsilon_2 m\beta_0 & 0 \\ 0 & 0 & k_3 & 0 & 0 & 0 & 0 \\ 0 & \eta\omega & 0 & k_4 & 0 & 0 & 0 \\ 0 & (1-\eta)\omega & 0 & 0 & k_5 & 0 & 0 \\ 0 & 0 & pz & 0 & 0 & k_6 & 0 \\ 0 & 0 & 0 & \rho_A & 0 & \rho_J & k_7 \end{pmatrix} \tag{3.10}$$

Where: $k_1 = -(\mu)$, $k_2 = -(\mu+q)$, $k_3 = -(\mu+z)$, $k_4 = -(\mu+\rho_A)$, $k_5 = -(\mu+\gamma)$, $k_6 = -(\mu+\rho_J)$, $k_7 = -(\mu)$, $m = \frac{\Lambda}{\mu}$, $Q = m\beta_0 + \epsilon_1 m\beta_0 + \epsilon_2 m\beta_0$
From the matrix 3.10 above and the numerical substitution of the parameters, it is determined that:

(1) Tr($\mathcal{J}_f$) < 0 , and,

(2) Det ($\mathcal{J}_f$) > 0

Thus, the DFE is locally asymptotically stable.

3.4.3. *Global Stability Analysis of the DFE.* We use the Lyapunov - Krasovskii method to analyse the global asymptotic stability.

Theorem 3.5. *Consider the autonomous system defined by $\hat{x} = f(x)$, with the equilibrium point of interest being the origin. Let A(x) denote the Jacobian matrix of the system, $A(x) = \frac{\partial f}{\partial x}$. If the matrix $F = A + A^T$ is negative neighborhood Ω, then, the equilibrium point at the origin is asymptotically stable. A Lyapunov function for this system is*

$$V(x) = f^T(x)f(x) \tag{3.11}$$

If Ω is the entire state space and, in addition, $V(x) \to \infty$, $[||x||] \to \infty$, then, the equilibrium point is said to be globally asymptotically stable.

The global stability analysis is performed by constructing the Jacobian matrix of the model system (2.1) and solving it at the DFE as shown in matrix 3.12

$$F(x) = \begin{pmatrix} k_1 & 0 & (1-p)z & -m\beta_0 & -\epsilon_1 m\beta_0 & -\epsilon_2 m\beta_0 & 0 \\ 0 & k_2+Q & 0 & m\beta_0 & \epsilon_1 m\beta_0 & -\epsilon_2 m\beta_0 & 0 \\ 0 & 0 & k_3 & 0 & 0 & 0 & 0 \\ 0 & \eta\omega & 0 & k_4 & 0 & 0 & 0 \\ 0 & (1-\eta)\omega & 0 & 0 & k_5 & 0 & 0 \\ 0 & 0 & pz & 0 & 0 & k_6 & 0 \\ 0 & 0 & 0 & \rho_A & 0 & \rho_J & k_7 \end{pmatrix} \tag{3.12}$$

Where: $k_1 = -(\mu)$, $k_2 = -(\mu+q)$, $k_3 = -(\mu+z)$, $k_4 = -(\mu+\rho_A)$, $k_5 = -(\mu+\gamma)$, $k_6 = -(\mu+\rho_J)$, $k_7 = -(\mu)$, $m = \frac{\Lambda}{\mu}$, $Q = m\beta_0 + \epsilon_1 m\beta_0 + \epsilon_2 m\beta_0$

From the matrix 3.12 above, the transpose ($F^T(x)$) of F(x) is as shown in matrix3.13:

$$F^T(x) = \begin{pmatrix} k_1 & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & k_2+Q & 0 & \eta\omega & (1-\eta)\omega & 0 & 0 \\ (1-p)z & 0 & k_3 & 0 & 0 & pz & 0 \\ -m\beta_0 & m\beta_0 & 0 & k_4 & 0 & 0 & \rho_A \\ -\epsilon_1 m\beta_0 & \epsilon_1 m\beta_0 & 0 & 0 & k_5 & 0 & 0 \\ -\epsilon_2 m\beta_0 & \epsilon_2 m\beta_0 & 0 & 0 & 0 & k_6 & \rho_J \\ 0 & 0 & 0 & 0 & 0 & 0 & k_7 \end{pmatrix} \tag{3.13}$$

Where: $k_1 = -(\mu)$, $k_2 = -(\mu+q)$, $k_3 = -(\mu+z)$, $k_4 = -(\mu+\rho_A)$, $k_5 = -(\mu+\gamma)$, $k_6 = -(\mu+\rho_J)$, $k_7 = -(\mu)$, $m = \frac{\Lambda}{\mu}$, $Q = m\beta_0 + \epsilon_1 m\beta_0 + \epsilon_2 m\beta_0$

From the matrix above, $\hat{F}(x)$ is as shown in matrix 3.14:

$$\hat{F}(x) = F^T(x) + F(x) \tag{3.14}$$

This implies that $\hat{F}(x)$ is as in matrix 3.15:

(3.15)

$$F^T(x) = \begin{pmatrix} 2k_1 & 0 & (1-p)z & -m\beta_0 & -\epsilon_1 m\beta_0 & -\epsilon_2 m\beta_0 & 0 \\ 0 & 2k_2+2Q & 0 & \eta\omega+m\beta_0 & (1-\eta)\omega+\epsilon_1 m\beta_0 & \epsilon_2 m\beta_0 & 0 \\ (1-p)z & 0 & 2k_3 & 0 & 0 & pz & 0 \\ -m\beta_0 & m\beta_0+\eta\omega & 0 & 2k_4 & 0 & 0 & \rho_A \\ -\epsilon_1 m\beta_0 & \epsilon_1 m\beta_0+(1-\eta)\omega & 0 & 0 & 2k_5 & 0 & 0 \\ -\epsilon_2 m\beta_0 & \epsilon_2 m\beta_0 & 0 & 0 & 0 & 2k_6 & \rho_J \\ 0 & 0 & 0 & \rho_A & 0 & \rho_J & 2k_7 \end{pmatrix}$$

since, all the eigen values of $\hat{F}(x)$ are not negative, then the matrix 3.15 is not negative definite and thus the DFE is globally asymptotically unstable. It implies that there exists a unique endemic equilibrium point.

4. Numerical Simulations

A numerical simulation of the system model 2.1 was carried out. The model was fitted with parameter values from reported studies with a few values estimated so as to give a meaningful analysis for this study. In this study the parameter values in Table 1 were used for numerical simulations. Numerical values are simulated at $0 \leq t \leq 300$ in days where we expect the disease to have fully taken it's course. A baseline population of 1000 is used as a representation of the total population. The simulations are performed with the help of PYTHON software, using the JUPYTER as an IDE and results are presented in graphical form.

4.1. **Media Impact.** The variation of the impact of media awareness on the number of asymptomatic is analysed. In figure 2, it is clear that if the messaging is impact-full, it results to a behaviour change lowering the infected numbers. It also extends the expected peak day which enables preparation of the medical facilities and personnel.

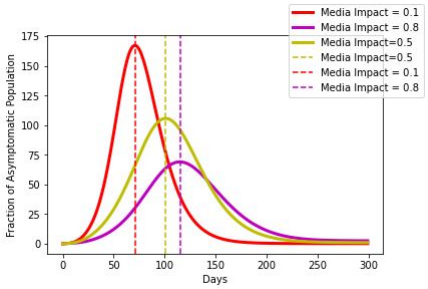

FIGURE 2. Effect of the Media Awareness on the Asymptomatic

4.2. **Impact of Face-Mask.** Increase in the efficacy of the face-mask lowers the asymptomatic population marginally. In figure 3 below, as the efficacy of the face-mask increased the number of asymptomatic reduces.

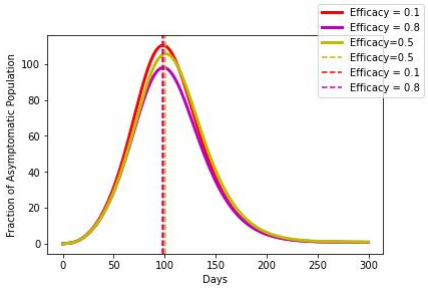

FIGURE 3. Effect of mask efficacy on the Asymptomatic

Increase in the consistent and compliant use of the face-mask leads to a drop in the number of asymptomatic as shown in the figure 4 below.

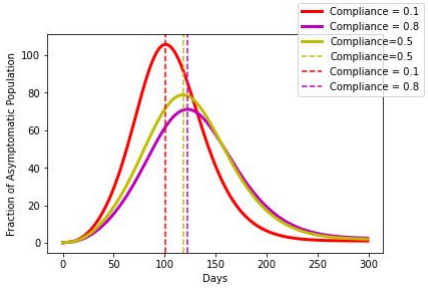

FIGURE 4. Effect of mask compliance on the Asymptomatic

Eikenberry *et al.* (2020), postulated that mask compliance and it's efficacy are multiplicative and it is paramount to enhance both. Figure 5 shows that if both the two factors are improved simultaneously, then, the impact is great.

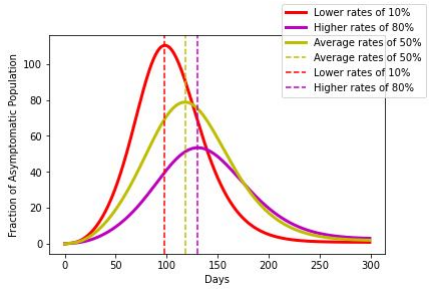

FIGURE 5. Effect of mask compliance and mask efficacy simultaneously on the Asymptomatic

4.3. **Effect of Quarantine on the Transmission.** If the quarantine rate is increased from the baseline value of 0.2% to 30%, there's a reduction of the of the asymptomatic cases from 101 t0 34. If the rate is increased to 80%, the asymptomatic reduces to 26, as shown in figure 5. If the quarantine period is reduced to 7 days, there's an increase in the asymptomatic. Increase of the quarantine to more than 28 days does not reduce the asymptomatic cases as shown in figure 7.

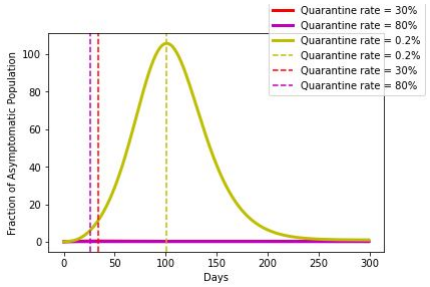

FIGURE 6. Effect of variations on quarantine rate to the Asymptomatic

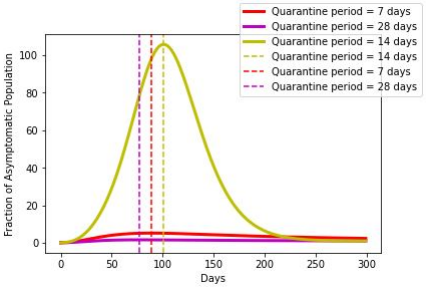

FIGURE 7. Effect of variations on quarantine period to the Asymptomatic

4.4. **Effect of Isolation on the Transmission.** Increase in the rate of isolation leads to a reduction in the number of asymptomatic as shown in the figure 8 below.

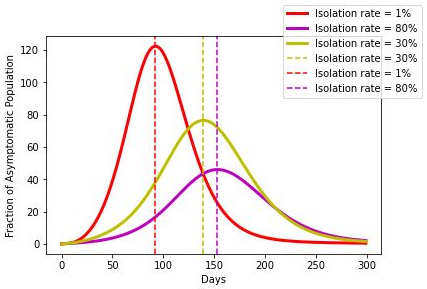

FIGURE 8. Effect of variations on isolation rate to the Asymptomatic

5. CONCLUSION

In this paper, a deterministic model is formulated to investigate the spread of a respiratory infectious disease, taking into account the application of NPI's such as media sensitisation, use of face-mask, quarantine and isolation. Qualitative analysis and some numerical simulations are conducted on the model. The study shows that, though NPI' s can lower the transmission rate, elaborate plans should be in place for the medication and the availability of a vaccine. NPI's extend the peak days and therefore give ample time for the public health officials to increase the medical capacities. It has also been shown that, media plays a major role in the progression of an infectious disease. Media awareness programs of the facts about an infection is key in ensuring that the public are sensitised to lower the transmission rate. The study further elaborates that, the mask efficacy and the consistent and compliant use of a face mask is multiplicative. Increase in the quarantine rate needs an elaborate contact tracing plan which may not be in place at the onset or some countries might not have the mechanism to contact trace. Isolation requires the medical facilities to be able to have isolation rooms or if home based care is applied, then it would be necessary for the governments to increase the capacity progressively. Generally, the application of NPI's is necessary since it is at the lowest cost of managing an epidemic.

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