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Study of dynamic behaviour of psychological stress during COVID-19 in India: A mathematical approach

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Abstract

In this study, a new attempt has been made using mathematical modelling to study dynamic behaviour and estimate the final size of spread of the psychological stress arising due to sudden outbreak of COVID-19 in India. The proposed mathematical model examines and includes different behaviours of transition from one process to another in current situation and study their propagation mode. We propose a mathematical model, where two different type of psychological stresses occur due to COVID-19 situation and its impact on people’s life such as their mental well being and happiness. We present some sufficient conditions for the vanishing or spreading of the psychological stress through qualitative and quantitative analysis. The basic reproduction number ($R_0$) of the model is computed and the local and the global stabilities of different equilibria are studied. Moreover, to better understand the level of psychological stress and decreasing mental well-being during the COVID-19 outbreak in India, we also conducted an online survey. Our findings establish several factors associated with level of psychological impact and mental health status. Based on the empirical analysis, we found that psychological stress has a significant negative influence on mental well being. Further, this study confirms that coping strategies with stress have significantly contributed towards the betterment in the mental well-being of the people. Numerical simulations are also given to illustrate the theoretical results. The results of the present study can be generalized to the society, Government, and others that they can adopt different strategies to avoid stressful situations during COVID-19 outbreak. The findings suggest that policy-makers, Government officials should focus on coping strategies to combat with pandemic disease.

Introduction

The coronavirus disease 2019 (COVID-19), originated from China in the end of 2019, is recognized as a pandemic disease by the World Health Organization (WHO). The higher virus transmission rate, increasing number of infected persons and the actual death rate have created havoc and hence led to tremendous fear and insecurity in the society. Moreover, lockdowns, the spread of false information and lack of knowledge have generated immense stress and anxiety in the public. Despite this fact, to attenuate or control the effects of the COVID-19 outbreak on mental health, typically no sufficient resources are suggested. Therefore, this outbreak raises several queries such as, is there a heightened stress/anxiety pandemic associated with this large-scale tragedy? And can we evaluate this phenomenon? Since the economic costs and physical/mental health associated with psychiatric or mental disorders are high, the analysis of spread of the psychological stress can be a key component [1–10].

Consequently, in this study, we consider a mathematical model to assess and evaluate the dynamic behaviour of spread of the psychological stress arising due to sudden outbreak of COVID-19 in India. This model classifies the psychological stress into two different classes: (i) Stress due to financial issues (financial stress) and, (ii) Stress due to health issues (physical/mental stress) including hypertension, blood pressure etc. To do so, we consider SEIR mathematical model by dividing total population into five time compartments namely, normal/happy people $H(t)$, exposed $E(t)$, physically stressed $S_p(t)$, financially stressed $S_f(t)$ and recovered $R(t)$. We also assume that the stress is transmitted to the susceptible population by direct contact with the stressed populations. It is assumed that susceptible individuals after being exposed to the stressed can move to any one of the following
stressed classes, namely, financially stressed and physically stressed with different transmission rates. Both types of stressed individuals may recover and after recovery it move to recovered class. However the rates of recovery may vary from one compartment to another. Keeping the above facts/assumptions in mind, a mathematical model is proposed as follows:

\[
\begin{align*}
\frac{dH}{dt} &= \Delta - dH - aH(S_F + S_p) \\
\frac{dE}{dt} &= aH(S_F + S_p) - dE - b\beta_F E - b\beta_p E \\
\frac{dS_F}{dt} &= b\beta_F E - \gamma S_F - \theta \mu_F S_F - c_F S_F + c_p S_F \\
\frac{dS_p}{dt} &= b\beta_p E - \gamma S_p - \theta \mu_p S_p - c_F S_p + c_p S_p \\
\frac{dR}{dt} &= \gamma S_F + \delta S_p - dR
\end{align*}
\]

Here \( \theta \mu_F \) and \( \theta \mu_p \) represent stress related deaths. We assume that stress related death occurs only if \( \theta \) is very large. In this work, we consider \( 0 < \theta < 1 \) and all the parameters are assumed to be non-negative, which are defined in Table 1.

The rest of the paper is organized as follows. We analyse the qualitative behaviour of the proposed model in Section ‘Theoretical analysis’, which includes discussing the positivity and boundedness of the solutions to system (1), calculation of Basic reproduction number, existence of equilibrium and their stability analysis. Section ‘Empirical Analysis’ shows empirical analysis to identify the influence of psychological stress & coping strategies on mental happiness. In Section ‘Numerical Results’, we provide numerical simulation results to validate our obtained findings. Finally, we give a conclusion of the work in Section ‘Conclusion’.

### Theoretical analysis

#### Positivity and boundedness of solutions

**Theorem 1.** The solutions of model system (1) are bounded.

**Proof.** Let \( N(t) = H(t) + E(t) + S_F(t) + S_p(t) + R(t) \) be the total population. Consider the region \( \Omega = \{(H, E, S_F, S_p, R) : H(t) + E(t) + S_F(t) + S_p(t) + R(t) \leq \frac{\Delta}{d}\} \). Then taking time derivative of \( N(t) \), we obtain

\[
\frac{dN}{dt} = \Delta - dN - \theta \mu_F S_F - \theta \mu_p S_p
\]

where \( H(t), E(t), S_F(t), S_p(t), R(t) \) are all non-negative to be biologically meaningful. Thus \( \frac{dN}{dt} \) is bounded by \( \Delta - dN \). This implies

\[
0 < N(t) \leq \frac{\Delta}{d} (1 - e^{-dt}) + N(0)
\]

Hence \( \lim \sup N(t) \leq \frac{\Delta}{d} \). Furthermore, for \( S_F = S_p = 0 \), if \( N(t) > \frac{\Delta}{d} \), then \( \frac{dN}{dt} < 0 \). Thus we have \( 0 < N(t) < \frac{\Delta}{d} \). Also \( N(t) \leq \frac{\Delta}{d} \) if \( N(0) \leq \frac{\Delta}{d} \). Consequently, region \( \Omega \) is invariant. Thus all solutions are bounded and independent of initial conditions. Furthermore, as \( \Delta > 0, d > 0 \), we have \( \frac{\Delta}{d} > 0 \), which implies the invariant set is positive. Thus all solutions of (1) that initiate in \( \{N(t) \leq \frac{\Delta}{d}\} \) are confined in \( \Omega \).

### Possible equilibria and basic reproduction number

The model system (1) admits two possible equilibrium points, namely, disease-free equilibrium (DFE) \( P^0 = (H^0, 0, 0, 0) = (\frac{\Delta}{d}, 0, 0, 0, 0) \) and Endemic Equilibrium (EE) \( P^* = (H^*, E^*, S_F^*, S_p^*, R^*) \). For any disease model, the disease-free equilibrium plays a significant role as it decides whether the infection will spread among the population or not. To determine the sustainability of infection, the concept of reproduction number \( R_0 \) is used which is the threshold value of the model [11], and can be calculated from next generation matrix \( FV^{-1} \) where \( F \) is the transmission matrix describing the persistence of new infections and \( V \) is the transition matrix which describes the remaining transfer terms. The reproduction number \( R_0 \) is given by the spectral radius \( \rho(FV^{-1}) \). After solving the next generation matrix, the obtained reproduction number at DFE for the system (1) is given as

\[
R_0 = \frac{abH0(\beta_p(d + \delta + \theta \mu_p + c_p) + \beta_F(d + \gamma + \theta \mu_F + c_F))}{(d + b\beta_F + b\beta_p)(d + \gamma + \theta \mu_F + c_F)(d + \delta + \theta \mu_F + c_F) - c_p c_F}
\]

#### Existence of endemic equilibrium

The existence of DFE \( P^0 = (H^0, 0, 0, 0, 0) \) is trivial. Thus we study the existence of EE \( P^* = (H^*, E^*, S_F^*, S_p^*, R^*) \).

**Theorem 2.** The endemic equilibrium point \( P^* = (H^*, E^*, S_F^*, S_p^*, R^*) \) exists whenever \( R_0 > 1 \).

**Proof.** The endemic equilibrium for model system (1) is \( P^* = (H^*, E^*, S_F^*, S_p^*, R^*) \), where \( H^* = \frac{d + b\beta_F + b\beta_p}{a(d_1 + d_2)} \),

\[
\begin{align*}
E^* &= d(d_1 + d_2) \\
S_F^* &= d_1 E^* \\
S_p^* &= d_2 E^* \\
R^* &= \left(\frac{\delta d_1 + \gamma d_2}{d} \right) E^* \\
d_1 &= \frac{b\beta_F c_p + \beta_p(d + \gamma + \theta \mu_F + c_p)}{(d + \gamma + \theta \mu_F + c_p)(d + \delta + \theta \mu_F + c_F) - c_p c_F} \\
d_2 &= \frac{b\beta_p c_p + \beta_p(d + \delta + \theta \mu_F + c_F)}{(d + \gamma + \theta \mu_F + c_p)(d + \delta + \theta \mu_F + c_F) - c_p c_F}
\end{align*}
\]

Since \( P^* \) is positive only when \( R_0 > 1 \). This completes the proof.

#### Table 1

| Parameter | Description |
|-----------|-------------|
| \( \Delta \) | Recruitment rate of susceptibles |
| \( a \) | Transmission rate of stress |
| \( b \) | Latent period of stress |
| \( \beta_s \) | Transmission probability of physical stress |
| \( \beta_F \) | Transmission probability of financial stress |
| \( d \) | Natural death rate |
| \( \mu_F \) | Death rate of physically stressed individuals |
| \( \mu_p \) | Death rate of financially stressed individuals |
| \( \delta \) | Recovery rate of financially stressed individuals |
| \( \gamma \) | Recovery rate of physically stressed individuals |
| \( \theta \) | Depression rate |
| \( c_s \) | Coefficient of transmission rate from stress related death to physically stressed population |
| \( c_F \) | Coefficient of transmission rate from stress related death to financially stressed population |
Stability analysis

**Theorem 3.** The DFE is locally asymptotically stable, provided the following hold:

\[
H_0 > 0, \quad H_1 > 0, \quad H_1 H_2 - H_3 > 0,
\]

where \(H_i\) are defined as

\[
H_0 = 1, \quad H_1 = a - B - C
\]

\[
H_2 = AB + AC + BC - c_p F - a H b \beta_p + \beta_F
\]

\[
H_3 = a c_p F + a H (b \beta_p + \beta_F) - ABC
\]

otherwise unstable, and \(A, B, C, D\) are as defined below in (5).

\[
A = (-d - b \beta_p - b \beta_F), \quad B = (-d - \gamma - \theta \mu_p - c_p), \quad C = (-d - \delta - \theta \mu_F - c_F), \quad D = -d, \quad M = D - a(S_p^* + S_F^*).
\]

**Proof.** The characteristic equation of system (1) corresponding to \(P^0\) is given by

\[
\begin{vmatrix}
-d - \lambda & 0 & -a H^0 & -a H^0 & 0 \\
0 & A - \lambda & a H^0 & a H^0 & 0 \\
0 & b \beta_p & B - \lambda & c_p & 0 \\
0 & b \beta_F & c_p & C - \lambda & 0 \\
0 & 0 & \gamma & \delta & -d - \lambda
\end{vmatrix} = 0,
\]

Simplifying the above determinant, we obtain the following characteristic equation:

\[
(-d - \lambda)(-d - \lambda)(-d - \lambda)(H_0 \lambda^3 + H_1 \lambda^2 + H_2 \lambda + H_3) = 0.
\]

Clearly the characteristic equation (6) has two roots given by \(\lambda_{1,2} = -d, -d < 0\). We are left with the cubic polynomial equation in (6). Applying Routh–Hurwitz criterion, the DFE \(P^0\) is locally asymptotically stable, provided (3) holds. This implies the DFE is locally asymptotically stable.

**Theorem 4.** The Endemic Equilibrium \(P^*\) is locally asymptotically stable, provided the following hold:

\[
H_0 > 0, \quad H_1 > 0, \quad H_1 H_2 - H_3 > 0,
\]

where \(H_i\) are defined as

\[
H_0 = 1, \quad H_1 = a - B - C - M
\]

\[
H_2 = MC(A + B)(M + C) + AB - c_p c_p - a H b \beta_p + \beta_F
\]

\[
H_3 = a H b \beta_p (C + M) + a H b \beta_F (B + M)
\]

\[
- a H^0 (b \beta_p c_p + \beta_F c_p + a H b \beta_p),
\]

\[
H_4 = ABCM - A MC c_p + a H b \beta_p (M c_p - C M) + a H b \beta_F M (c_p - B)
\]

\[
+ a H^0 b S^*(c_p \beta_p c_m + c_p \beta_F c_p) - a H^0 b S^*(b_m + C m p).
\]

otherwise unstable, where \(A, B, C, D\) are as defined in (5).

**Proof.** The characteristic equation of system (1) corresponding to \(P^*\) is given by

\[
\begin{vmatrix}
D - a(S_p^* + S_F^*) - \lambda & 0 & -a H^0 & -a H^0 & 0 \\
- a(S_p^* + S_F^*) & A - \lambda & a H^0 & a H^0 & 0 \\
0 & b \beta_p & B - \lambda & c_p & 0 \\
0 & b \beta_F & c_p & C - \lambda & 0 \\
0 & 0 & \gamma & \delta & D - \lambda
\end{vmatrix} = 0,
\]

and \(A, B, C, D, M\) are as defined in (5). Following the similar steps as in Theorem 3, we obtain the following characteristic equation:

\[
(D - \lambda)(H_0 \lambda^3 + H_1 \lambda^2 + H_2 \lambda + H_3) = 0.
\]

where \(H_i\) are as given in (8). Clearly the characteristic equation (9) has one root given by \(\lambda = -d < 0\). We are left with the fourth-order polynomial equation in (9). Applying Routh–Hurwitz criterion, the endemic equilibrium \(P^*\) is locally asymptotically stable, provided (7) holds. This implies the endemic equilibrium \(P^*\) is locally asymptotically stable.

**Theorem 5.** The EE \(P^*\) is globally asymptotically stable, provided the following hold;

\[
(i) R^*(\gamma S_p + \delta S_F) > (\gamma S_p^* + \delta S_F^*)
\]

\[
(ii) a S_p^* a H H^* + b C \beta_p E^* S_p^* + C c_p S_F^* S_p^* > \left( a a H^* + b a H^* E - a H H^* + b \beta_p E + C c_p S_F^* \right) S_p^* + \left( a a H^* + b a H^* E - a H H^* + b \beta_p E + C c_p S_F^* \right) S_F^*
\]

\[
+ g S_p^* (b \beta_p E^* S_p^* + c_p S_F^* S_p^*),
\]

for some non-negative constants \(a, b, c, g, f\).

**Proof.** We define the following Lyapunov function

\[
V(t) = \frac{d}{2} H - H^2 + \frac{b}{2} E - E^2 + C (S_p - S_p^*)^2 + \frac{d}{2} (S_F - S_F^*)^2 + \frac{f}{2} (R - R^*),
\]

where \(a, b, c, g, f\) are all constants. Computing time derivative of \(V\) along the solutions of (1), we obtain

\[
\frac{dV}{dt} = a (H - H^*) (A - d H - a H (S_p + S_F)) + b (E - E^*)
\]

\[
\times (a H (S_p + S_F) - d E - b \beta_p E - b F E) + c_p (S_p - S_p^*) (b \beta_p E - d S_p - \gamma S_p - \theta \mu_p S_p - c_p S_F + c_F S_F) + g (S_F - S_F^*) (b \beta_p E - d S_F - \theta S_F - \theta \mu_F S_F - c_p S_F + c_F S_F) + f (R - R^*) (\gamma S_p - \delta S_F - d R).
\]

At equilibrium, we have

\[
\Delta = d H^* + a H^* (S_p^* + S_F^*)
\]

\[
a H^* (S_p^* + S_F^*) = (d + b \beta_p + b F E)
\]

\[
b \beta_p E^* + c_p S_F^* = (d + \gamma + \theta \mu_p + c_F) S_F^*
\]

\[
\gamma S_p^* + \delta S_F^* = d R^*
\]

Using (13) in (12) and simplifying, we obtain,

\[
\frac{dV}{dt} = -a (d - d (S_F + H)) (H - H^*) (S_p - S_p^*) a H^* (H - H^*)
\]

\[
- b a H^* (E - E^*) - b \beta_p E - b F E
\]

\[
+ \frac{g b \beta_p E^* S_p^* - c_F g S_F^* S_p^*}{S_p^*} - (S_p - S_p^*) a H^* (H - H^*)
\]

\[
- b a H^* (E - E^*) - c_F \beta_p E - C c_F S_F^* + \frac{b \beta_p E^* S_p^* + C c_p S_F^* S_p^*}{S_p^*} + \frac{c_F S_F^* S_p^*}{S_p^*}
\]

\[
\frac{(R - R^*)}{R^*}
\]

\[
\times \left( f \gamma S_p + f \delta S_F + f R S_p - f \delta S_F - R^*\right)
\]

\[
- a b H^* (E - E^*) (S_p + S_F) - \frac{b a H^* S_F^* (E - E^*)^2}{E^*}.
\]

Now using (i)-(iii) of (10), we obtain \(\frac{dV}{dt} < 0\). Thus one can guarantee that solutions of equations converge to endemic equilibrium point, if the parameters of model system (1) satisfy (i)-(iii).
Empirical analysis

Reliability and validity

Partial least square structural equation modelling (PLS-SEM) technique was used to test the proposed hypotheses. The measurement items (10 items) for perceived stress scale were derived from [12], due to having better psychometric properties [13]. Keeping in view the situation of COVID-19 all the negative items were framed into positive worded and straightforward for data collection. Further, we have measured the internal consistency of perceived stress scale using Cronbach’s Alpha (0.89) and composite reliability (0.909) that was satisfactory in the present context. Furthermore, measurement items for Psychological well being were taken from Warwick-Edinburgh Mental Well-being Scale [14]. The shorter version of mental well being comprises 7 positive worded items used by [15]. The scale exhibited composite reliability 0.746, that is more than the recommended value. Additionally, the items for “coping strategies” with the COVID-19 stress were developed by researchers themselves based on literature review such as “I am using social media platforms to avoid stressful situations”, “When I am stressed, I like to spend time with family”, “I always look on the bright side of things regarding these kind of situations”, “I am using digital entertainment platforms to avoid stressful situation”, “I am doing Exercise/meditation/yoga/cooking to divert my mind”. Interview process was also followed to know about the various activities to avoid stress during this crunch. The draft was shown to senior professors to ensure the content validity of the scale. After this long process, due care was taken and their suggestion were incorporated in the scale. The Cronbach’s Alpha value for coping strategies is 0.739 and composite reliability was found 0.851 that was above the threshold value.

In the PLS-SEM, Cronbach’s alpha as a measure of internal consistency is considered as traditional criteria that provide conservative measurement resulting into low alpha or reliability values due to its sensitive nature towards items and underrates internal consistency [16]. In this view, extant studies posited that composite reliability as a better replacement of Cronbach’s alpha. In PLS-SEM, reliability overestimates the term internal consistency reliability and provides high reliability value than Cronbach’s alpha [17,18]. The threshold limit for composite reliability is 0.70 [19].

We have examined the value of average variance extracted (AVE) to ensure the convergent validity and it may be defined as “the extent to which there is a high correlation between theoretically identical constructs” [20]. The recommend value of AVE is 0.50 [19] which satisfactory in the present context. To ensure the discriminant validity of the constructs, the square root of AVE was done (diagonal values) and found above than the threshold limit [19]. It may be defined as the “an extent to which a certain construct differs from other constructs” [20]. The discriminant validity presented in Table 2, the value reported in bold and diagonally.

Structural model

In the present study, we have found that psychological stress has significant negative influence on the mental well being of the population. The Fig. 1 and Table 3 suggest that the value of path coefficient, T statistics, and probability value (significance value) at 95% (between ±1.96) confidence level for perceived stress to psychological well being is (−0.206, 3.23, p < 0.05). The path value for coping strategies to psychological well being (0.259, 4.152, p−value < 0.05) simply states that strategies that people are adopting during COVID-19 has significant positive impact on mental well being of the population. Further, coping strategies to perceived stress (−0.006, 0.84, p > 0.05), signifies that coping strategies are directly helping people to increase their level of happiness during pandemic disease COVID-19 and that will turn out to reduce the psychological stress indirectly.

Based on the findings of the present study we can conclude that the pandemic has posed the people at large to numerous challenges, from a greater disturbance to the daily life activities such as working, moving outdoors for any related activities, low over social interactions and much more. Additionally, it has for sure of its grave nature, has posed people at large to many physical and mental challenges too. Undoubtedly, the people who are caught up into the illness of this pandemic, have no way out other than getting themselves treated, which in turn becomes vital too. However, the ones who are not in contact with this disease are much thoughtful about the spread of this pandemic thereby exposing their mental health to numerous challenges. People are much stressed back at their respective places thinking and over thinking about this pandemic because of its deadly nature. People at large are being exposed to numerous information about this pandemic, also the news across globe about the increasing number of reported cases and deaths. That has created a fear amongst people thereby leading them to stress like situation. This acts an antecedent condition to the development of stress in people and thereby hampers their psychological well-being.

Numerical results

In this section, we perform numerical simulation to support our analytical results. In our case, we consider that, from the total involved population, 90% of the population will have happy people, and 10% individuals manifest the exposed class. To the best of authors knowledge, no literature study for dynamic behaviour of psychological stress is available for quantifying transition mechanisms from one class to another class. Thus, we have chosen values of most of the parameters
The system (1) is simulated for different set of parameters using MATLAB. The parameter values are selected as \( \Delta = 0.0003, \delta = 0.01, \gamma = 0.02, \sigma = 0.2, \beta_F = 0.03, \beta_P = 0.02, \mu_F = 0.0001, \mu_P = 0.00005, \) and \( \theta = 0.1. \) This is to be noted that all the parameters are in per day. The values for \( c_F = 0.00002, \) and \( c_F = 0.00001 \) are assumed under the assumption that physically/mentally stressed individuals have more chances of getting financially stressed as there may be financially losses due to medicines, health check-ups etc. For this set of parameters, the basic reproduction number \( R_0 \) is 15.3471. Since \( R_0 > 1, \) the endemic equilibrium comes into existence and is \( P^* = (0.065159, 0.013815, 0.005446, 0.016073, 0.898878). \) Corresponding to this EE, the eigenvalues are \( -0.0003, -0.0220, -0.0190, -0.0100, -0.0003. \) All the eigenvalues have negative real parts. We have shown the stability of EE for initial conditions \( (0.9, 0.1, 0, 0, 0) \) converging to the equilibrium point in Fig. 2.

Fig. 3 shows the typical behaviour of the stressed classes in the absence of any recovery, that is \( \delta = \gamma = 0 \) keeping all other parameters same. We can observe that the total population become stressed (physically and financially) in this situation. Observing the infected compartments carefully, we can say that the stressed individuals rise sharply in the shortest time from the initial state and reach to the highest level within a short interval.

Furthermore, we observed the behaviour of population for various recovery rates of financially and physically stressed people, in Figs. 4 and 5. These results of infected compartments as shown in Figs. 4 and 5 gives quiet effective information regarding coping of stress among the people which is not clear in Figs. 2 and 3. From the numerical simulations depicted in Fig. 4(b), We can easily observe that as \( \delta \) increases, the rate of recovery also increases. In the contrary, for smaller values of \( \delta, \) the population is recovering at a slower rate, as shown in Fig. 4(a). Similarly the next numerical simulations illustrates the similar behaviour of population for various values of \( \gamma, \) as shown in Fig. 5. We can observe that the rate of recovery of physically/mentally stressed population is more (or less) as we increase (or decrease) the value of \( \gamma. \) Hence, these graphs demonstrate that the recovery rate parameters have a significant impact on the spread of stress in the population. For higher recovery rate, the rate of spread of stress will be less as one would expect logically. In real life situation, we can increase the values of parameters \( \gamma \) and \( \delta \) by practising various activities, such as exercise, yoga, meditation, involvement in various household activities (during lockdown period), hobbies, listening to music, spending less on unnecessary activities. Digital media is also helping a lot now a days to reduce such stress.

### Conclusion

Here, we provided and analysed a differential equation based mathematical model to explore the dynamic behaviour of the psychological stress arising due to sudden outbreak of COVID-19 in India. The pattern of spread of the psychological stress among the population has been divided into five stages: (I) Happy or normal class, (II) Exposed class, (III) Physically or mentally stressed class, (IV) Financially stressed class, and (V) Recovered class. In addition to the development of model, the basic reproduction number \( (R_0), \) and the local and the global stabilities of different equilibria are studied. Beside the theoretical analysis, the empirical analysis has also been done to establish the impact of psychological stress on physical or mental health of people of the India, in the current scenario. In summary, the numerical and empirical analysis illustrated that perceived stress has a negative impact over the psychological well-being of the people, which is but if obvious kind of phenomena. The perceived stress can act as a big hurdle in letting people lead and maintain their psychological well-being. This can cause people to experience episodic stress, acute stress and others and in result in negative thoughts that might put them to certain psychological challenges and can in turn disturb their routine life. Apparently, people have been taking some pro-active and active measures to ensure that they are not exposed to such situations. Based on the results, the present study has found very interesting findings that the people have been practising things like yoga, meditation, and physical workout indoors to keep themselves healthy, fit and avoid stress. In addition, people have been engaging themselves much in some or the other activities, which can keep them busy and have been many indoor options such as cooking, making crafts, reading, gardening, indoor games or being digitally interactive. This assures that they are busy and can do away with any antecedent conditions that might cause stress to people and as result can hamper their psychological well-being. These activities might not act as a definite solution to address the stress amongst people and assure their well-being but they can act as a short-term tactics to keep oneself stable in this kind of situation where stress can be of huge weight to anyone’s health. Therefore, studies in this area are emerging and still unexplored. The researchers are suggested to conduct more studies and suggest some measures to overcome from these kind of stressful situations. Because, stress can also create panic like situations, negative emotions and moods that can hamper one’s well-being for sure but can also result in the spread of its impact to their social group. If, not taken much care, it can lead to poor social relations too as one starts feeling lone and thinks much and can react in ways which might be out of expectations of their peer or social group.
Fig. 4. Variation of $S_p$, $S_f$ and $R(t)$ for (a) $\delta = 0.005$, and (b) $\delta = 0.02$.

Fig. 5. Variation of $S_p$, $S_f$ and $R(t)$ for (a) $\gamma = 0.01$, and (b) $\gamma = 0.04$.

CRediT authorship contribution statement

Subit K. Jain: Conceptualization, Supervision, Formal analysis, Writing – review & editing, Visualization. Swati Tyagi: Supervision, Methodology, Validation, Investigation, Writing – original draft, Writing – review & editing. Neeraj Dhiman: Supervision, Writing – review & editing, Investigation. Jehad Alzabut: Visualization, Writing – review & editing, Formal analysis.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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