## INTRODUCTION

### 1.1      COVID-19 Pandemic- Setting the stage for an information avalanche:

Ever since the first reported case in early December 2019, the number of patients infected with COVID-19 was on an exponential rise in the following months. Governments and health ministries worldwide began implementing various social distancing and lockdown measures to limit the spread of the disease. Eventually, on 11th March 2020, the WHO characterized COVID-19 as a pandemic, considering its alarming levels of spread.

What made the pandemic more dreadful, was the huge number of uncertainties surrounding it. Not much was known about the cause, spread, and pathophysiology of the disease. The majority of the population was well-familiarized with the clinical manifestations of the infection, but the pandemic had certain psychological impacts as well. The lockdown and isolation measure further aggravated these problems leading to high levels of stress, fear, pathological anxiety, post-traumatic stress disorder, and depression.

Healthcare workers concerned with obtaining swabs and testing the samples inevitably developed stress owing to the high risk of exposure and increased workload. The nature of the spread of the infection through droplets and aerosols particularly put dental professionals at very high risk. The stresses were further aggravated owing to the isolation norms which inculcated loneliness, fear, and burnout. The healthcare professionals working at the frontiers were constantly looking for information pertaining to updates in the epidemiology of COVID-19, the pathogenesis of SARS-CoV-2, and breakthroughs in diagnostics and treatment. Search for updates pertaining to COVID-19 on the internet had leaped by a margin of 50-70% across all the generations.

Consequently, there was an avalanche of evidence-based research and scientific knowledge to provide clarity to the global population and the means to tackle the pandemic. To stay abreast with the research explosion, scientific journals started publishing pre-prints and hastily peer-reviewed papers at a very high pace. Evidence of over 75,000 scientific papers related to COVID-19 published across the world by November 2020 was found. Additionally, an overwhelming number of clinical trials were also in motion with about 1100 trials listed in the National Library of Medicine

Registry of Clinical Trials. This led to a gradual blending between true evidence-based information, anecdotal evidence, and gross misinformation/disinformation.

## 1.2    The advent of 'Infodemic':

Misinformation refers to inaccurate or false information based on unsubstantiated claims, rumours, and conspiracy theories. A more recent definition was given by Swire-Thompson & Lazer in 2020 as "information that is contrary to the epistemic consensus of the scientific community regarding a phenomenon." Disinformation, on the other hand, refers to the intentional dissemination of false information to a target audience with the intention of deception or manipulation. Given the fact that intentionality is a very thin line and is impractical to determine in most cases, misinformation and disinformation are generally considered together as "information pollution." These harbor roots for anti-social and anti-science elements to misguide the vulnerable mindset of the population.

Together, true information along with misinformation and disinformation have served to add oil to the fire of pandemic, in the form of an 'infodemic'. The term infodemic, coined in 2003 by political scientist David Rothkopf in Washington Post, he mentioned it as a blend of 'Information' and 'Epidemic' and explained it as "an onslaught of speculations and overabundance of information that unraveled the menacing effect on human life." It is a metaphoric shift from the term 'epidemic' in which false information travels fast and far just like an epidemiological pathogen. The WHO defines an infodemic as an 'overabundance of information— some accurate and some not— that occurs during an epidemic.' It refers to explosive volumes of information pertaining to a specific topic (in the present scenario, the COVID-19 pandemic) occurring within a short period of time. The infodemic serves to create havoc within an already existing pandemic. The diffusion of true and false information makes it extremely difficult for people to distinguish between the two and find reliable sources of information for guidance. The superimposition of an infodemic over a pandemic is rightly referred to as a 'secondary virtual epidemic' in the current internet-based society.

In February 2020, WHO also cautioned that "we are not just fighting an epidemic; We are also battling the trolls and conspiracy theorists that push misinformation and undermine the outbreak response; We are fighting an infodemic" (Ghebreyesus,

2020). The infodemic was also declared as the biggest challenge faced by individuals checking for facts to date (Suarez, 2020).

While the concept of infodemic has recently gained much attention from health organizations globally, it has always been observed in association with all the previously occurring pandemics across the centuries. The only difference is that in the present-day world, misinformation, disinformation, and misinformation propagate at a much faster rate owing to the accessibility to the internet by a majority of the population.

The popularity of social media websites and applications such as Facebook, Twitter, Instagram, Youtube, and WhatsApp allows a message to be viewed by millions of people within a matter of few minutes. These platforms have penetrated deep into the center of present-day societies, a phenomenon rightly described as the rise of 'platform society.'
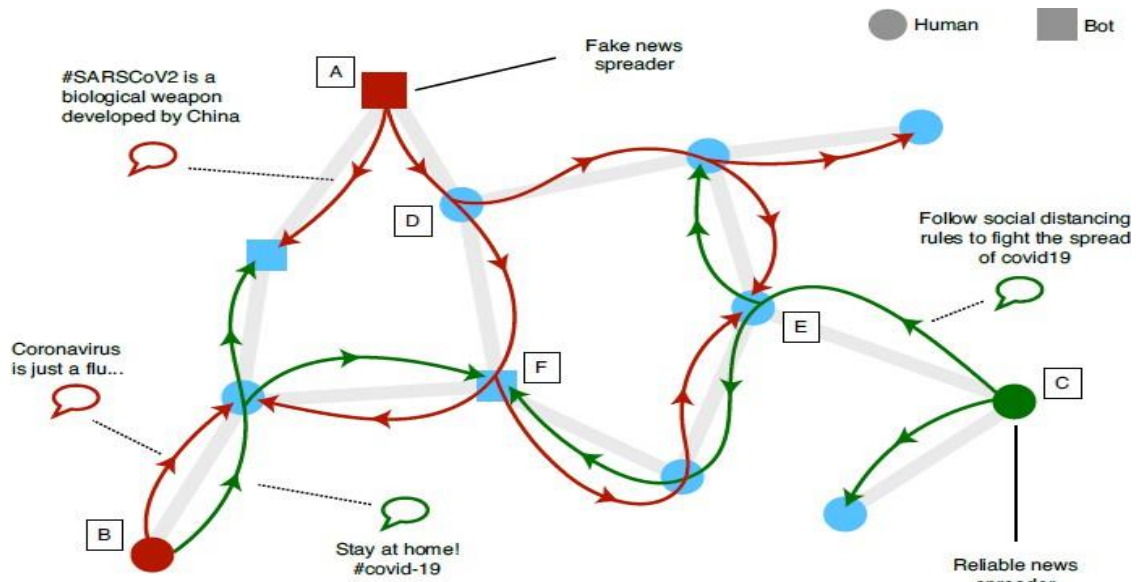


**Fig. 1 : The mechanism of an infodemic as depicted by Gallotti et al. in a recent review on human behaviours and risks of infodemic in response to COVID-19.**

### 1.3    Effect of Infodemic on the Pandemic:

The infodemic makes the pandemic worse in the following ways:

i.      Projects situation worse than it actually is, thereby discouraging the people and emotionally draining them.

ii.     Inculcates fear and anxiety amongst the population, which may develop into depression and suicidal tendencies.

iii.    Makes it difficult for the general population and the healthcare workers to trust any information provided to them.

iv.     Affects the decision-making process of the policymakers and healthcare workers who are looked up to for immediate answers whenever a piece of new information comes to the surface.

v.      The severe undermining of the quality of published research makes it easy for political figures and cults to use them to their advantage for propagating their beliefs.

vi.     Carefully crafted messages on social media can effectively target 'echo chambers', influencing them to take an inhuman course of action in any desired context.

vii.    Promotes vaccine hesitancy and misallocation of resources.

## 1.4    Need to study the infodemics

The primary need is to understand the characteristics of the infodemic which are closely related to bioinformatics is a combination of of biology, statistics, and data science.

Several determinants of infodemic have been identified which include:

- Sources of information

- Communication channels

- Messages content quality of information

- Health emergency context (social consensus, public opinion)
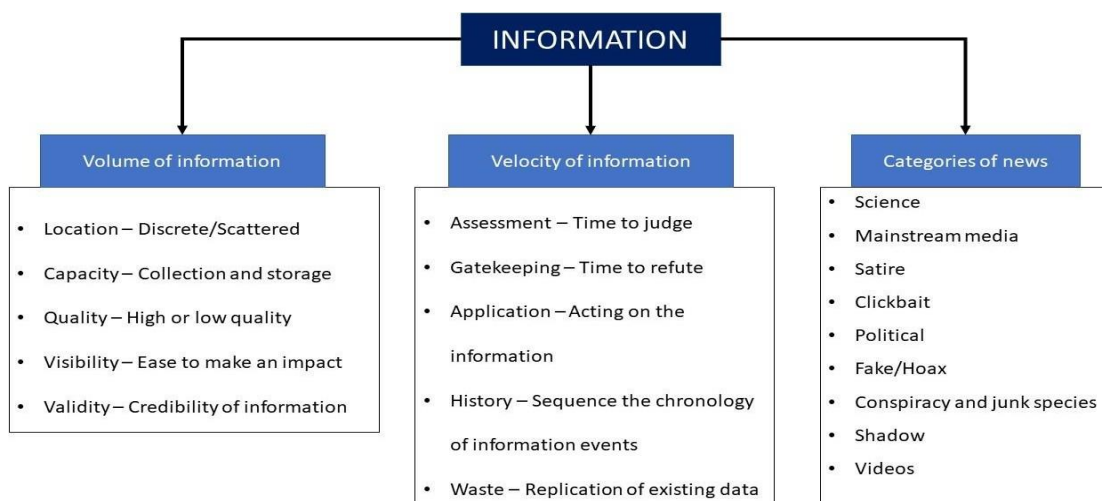
- Online community structure and consensus.



**Fig. 2 : Various parameters associated with the information in infodemic**
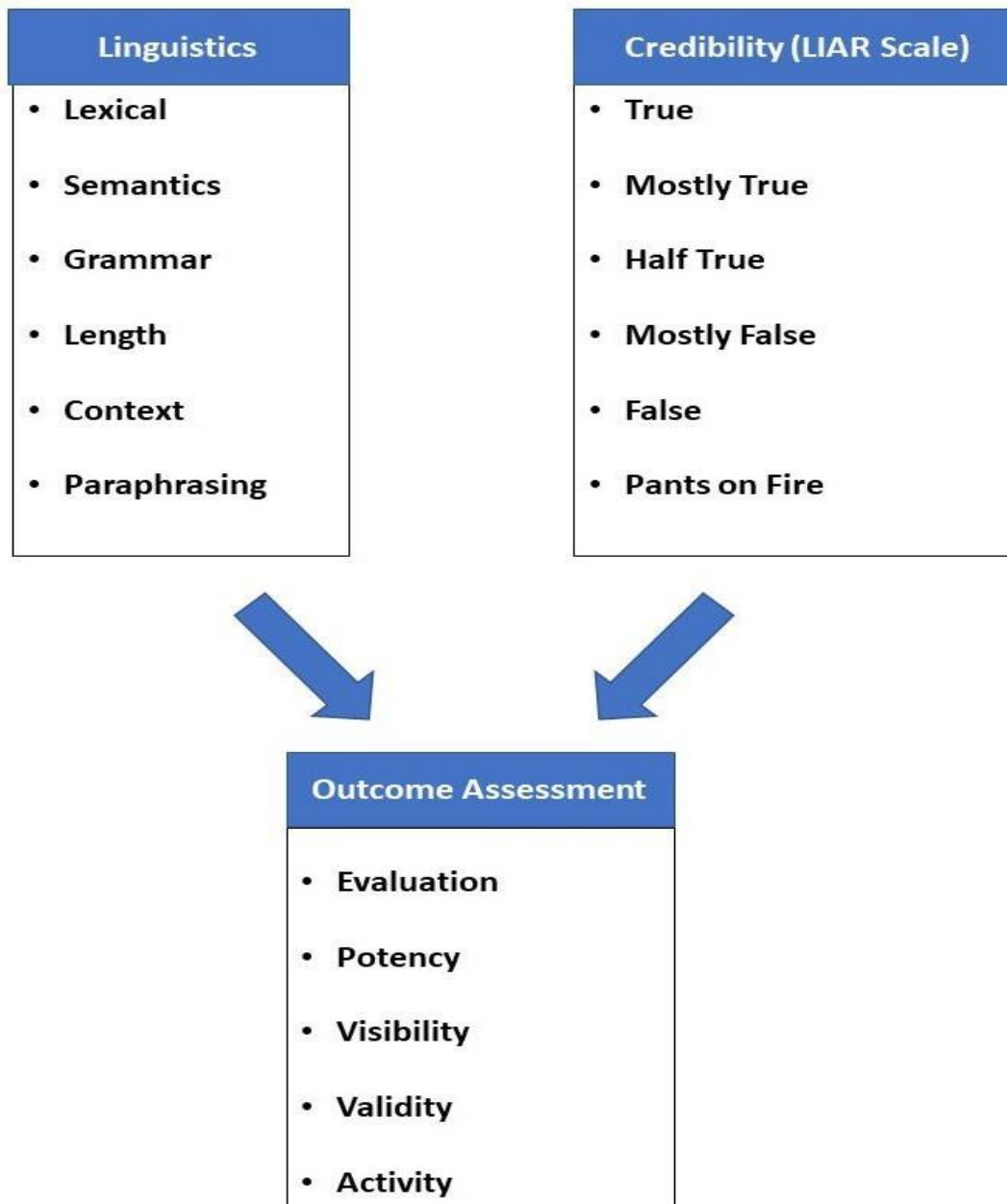
**Fig. 3 : Characteristics of misinformation in infodemic**

## 1.5    The concept of 'Infodemiology':

The study of these determinants of infodemic was termed information epidemiology or in short, 'infodemiology' in 2002 by Prof. Gunther Eysenbach. He defined infodemiology as "the study of the determinants and distribution of professionals and patients to the quality health information on the Internet." Infodemiology involves identifying the extent of knowledge of the population, their  practice,  markers  for

**health information and misinformation—[8]which may be useful in guiding health**

correct  information,  and  existent  translational  knowledge gaps. A modified version

of the definition was later published as "the science of distribution and determinants of information in an electronic medium, specifically the Internet, with the ultimate aim to inform public health and public policy." Therefore, the scope of the present study lies large within the relatively unexplored field of Infodemiology.

This novel scientific discipline will reach its peak of development owing to the urgent need for unraveling the complex propagation patterns of the infodemic. A trans-disciplinary approach integrating algorithms, mathematical sciences, computer sciences, communication technology, information technology, social and behavioral sciences, and public health research sectors is the only way to tackle a problem as complicated as the infodemic. The ultimate goal is to generate evidence by research for the development of policies, methods, and interventions for the prevention and management of infodemic outbreaks.

The infodemic management revolves around four disciplines: (i) understanding and intervening in misinformation spread, (ii) eavesdropping on public anxiety and queries – 'infoveillance', (iii) Endorsing considerate threats and health expert recommendations, and (iv) empowering individuals to identify correct information and act affirmatively. A team-based approach for community field visits, panel discussions, mass health education, and online training programs can aid greatly in promoting the health literacy essential to combat the infodemic.

## 1.6 Understanding misinformation:

In an experimental setting, when a simulated crime or accident is displayed to a population, people interpret it with their own level of perception. When tested for event memory at a later time, various m$_9$isleading elements are added into each individual's version of the story which deviates from the actual incident. The deviations further amplify when the information is transferred to the second set of individuals from the first one. This phenomenon is scientifically referred to as the 'Misinformation effect' (Loftus, 2005). Similarly, in the scenario of COVID- 19, a misinformative article about masks could potentially change people's perceptions about wearing a mask or the safety offered by the practice. The association of negative events with masks would increase the likelihood of avoidance in the future.

### 1.6.1    Sources of information:

The sources may be broadly divided into formal and informal ones. Form sources include those from WHO, Centers for Disease Control and Prevention (CDC), governments, and health ministries in the form of websites and Apps, portals, and social media channels. These sources provide realistic information and update it frequently in pace with the developments in research.

The informal channels are majorly responsible for the initiation of chains of misinformation. Social media platforms, television, newspapers, independent scientific articles, and messages from political figures and celebrities were found to be the potential means for the spread of misinformation.

### 1.6.2    Mechanism of misinformation perception:

1.      Confirmation bias – People are more likely to believe in information that coincides with their trajectory of thinking. In this case, the population being afraid of COVID-19 was more susceptible to the information stressing on the negative consequences of the infection.

2.      Reinforcement bias – Repetition of information from multiple sources makes it more likely to be perceived as true without critical analysis. Today's social media platforms utilize an effective algorithm to personalize data provided to individuals based on filter bubbles $a_1n_0d$ echo chambers. Similar type of information is provided to users with a similar mindset, thereby promoting the 'Misinformation effect'.

3.      Selective exposure bias – Likewise, once the mindset of the user is determined, the users are selectively provided information in line with their thinking. The other information which contradicts this set is kept away. In this manner, the media platforms provide information 'personalized on a platter' to the individuals based on their 'taste of likes and dislikes.' Consequently, one-sided information is presented which may deviate a set of the population away from the truth.

4.      Systemic bias and belief bias – With people looking for information more deliberately rather than analytically, the chances of acceptance for information that is of low quality or non-systematically generated, are higher than usual.

For instance, people would search for information that supports their prior beliefs and fears. They would deliberately look for matching information on the web and rely on their conclusions without questioning its nature.

## 1.7    Scenario in developing countries:

The health literacy levels, healthcare infrastructure, and resource allocation are poorer in developing countries such as India. These settings make their resident population more susceptible to the effects of the infodemic. Healthcare systems are under-resourced and the political systems are quite fragile. While the implementation of laws and punishments may prove useful in developed countries, these are not usually tolerated well in developing countries. Civil issues may ensue leading to further sociodemographic complications.

The trust of the population in the government is generally found to be lower in such countries making cooperation with the policies difficult. The threat of disinformation decreases trust in organizations and democratic systems (Bradshaw and Howard 2018). The disinformation may be used to rig election results by targeting echo chambers in democratic society through a well-tailore$_1$d$_1$campaign (Guess et al., 2019; Lazer et al. 2018). Such campaigns may result in polarization in populations (Benkler, et al., 2018; Osmundsen et al. 2020) Therefore, it is a particularly sensitive matter to implement infodemiological measures in India with extreme caution. A primary step is to make the individuals and population as a whole realize their role in contributing to the fight against the infodemic.

**The existing need to understand Infodemics in India:**

- The factors promoting the infodemic in India need to be identified and Research activities in India focusing on understanding the underlying factors that promote infodemic as well as exploring means that can practically counter the tide of misinformation, need to be carried out.
- Critical quality compromises have been noted in studies concerning SARS-CoV-2 which have contributed significantly to the infodemic. It has been reported that only about half of these studies critically appraised the quality of original records whereas only 33% of the studies registered their protocol in a standard scientific database before beginning the study. (Borges do Nascimento et al., 2022) Likewise, in India, a large number of articles in

journals comprising editorials, commentaries, and perspectives were published by an expedited route bypassing a critical review of their contents.

- To actually flatten the curve of misinformation, social media should incorporate measures to ensure the validity of for the content being made visible on their website to millions of users. A fact-checking mechanism must be integrated into their system algorithms. Right now, although they issue warnings on suspicious content, it is more of a 'You choose' kind of caution, wherein they allow the users to pick sides. Posts without warning are then accepted as true information without much critical appraisal. Moreover, there is scanty data on the local factors influencing misinformation and seeking behaviors of the Indian population.

- These sources of misinformation about COVID-19 for the subset of healthcare professionals need to be explored. There is still a need to study the negative impact of health misinformation on the healthcare professionals of India.

- Very little evidence is available on the prevalence of misinformation amongst them and how they process the information provided to them, the impact of the infodemic on their health behaviors and mental well-being, and specific countermeasures provided to them by the Government to remedy the situation.

- The interpretation of misinformation also may not be very accurate in many studies, owing to the lack of a standard scale or method to identify it and distinguish it from true information.

- The economic effects of the infodemic on the healthcare professionals of India have not yet been studied.

- There is also a need for evolving better methods for the detection of misinformation related to healthcare, since their propagation is perpetually continuing and the methods of propagation are in a state of constant evolution themselves.

- Evaluation of methods to more efficiently combat health misinformation and its determinants across different social media platforms is also needed.

- A goal to be achieved is to create an integrated system of communication in which the myths and misinformation are 'pre-bunked' rather than being

debunked at a time by which the damage has already reached thousands or millions of people.

## 1.8    Responsibility of Individuals:

It is important to understand that in the setting of democracy, each individual carries a certain responsibility towards contributing to the infodemic management. It majorly lies in systematically verifying the received information, creating 'filters' that allow only reliable information to pass, creating 'barriers' that restrict the dissemination of misinformation, and lastly, propagating the true information to society. In this manner, the super highway of misinformation can be reduced to a two-lane road for a good cause. If all the individuals pause for a moment to critically analyze the information being spread on social media, it could drastically reduce the amount of misinformation being circulated on these platforms.

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| Trust WHO | Identify evidence | Avoid fake news | Support open science |
| Determine if the information really adds up, even if it's from a secure source and has been shared before | | | Report harmful rumors |
| Protect privacy | Open (quality) data | If you can't confirm the information's source, its usefulness, or whether it's been shared before… **better not to share** | |
| Confirm that the information has been shared before by other people | | Participate responsibly in social conversations | |
| Continue collaborating | Share information responsibly | Confirm the source, in particular the threads on WhatsApp | |
| If the information is not confirmed, it is better not to share it | | | Keep learning |

**Fig. 4 : Responsibilities on the part of individuals in combatting the infodemic**

## 1.9    Importance of infodemiology in healthcare professionals:

It is a well-known fact that education contributes significantly to decreasing belief in COVID-19 myths and false information. Information from reliable sources such as government websites or portals further adds to this relief. The general population looks up to the viewpoints of professionals related to healthcare industries such as pharmacists, nurses, and doctors on the dietary and preventive measures, and treatment of COVID-19. Often, medical experts are asked to opine on a media platform in relation to the emergence of some new scientific evidence. Given the urgency of reporting, the experts may not find the time to carefully evaluate the evidence presented to them.

We, being the face of hope of the general population, also try to stand up to theirexpectations and push ourselves in providing these assessments based on the little amount of data presented to us. We try to act steadfast and be convincing, even though the data available is insufficient and highly uncertain. Thereby, healthcare professionals may inadvertently contribute to the misinformation effect by supporting scientifically unsound claims.

The healthcare workers had themselves developed mental and physical fatigue due to various reasons:

(i)     Diversion of the workforce to combat the pandemic

(ii)    Lack of working personnel in the hospitals

(iii)   Morbidity and mortality of patients generating fear and panic

(iv)    Increased risk of exposure from the infected patients

(v)     Loneliness and discrimination due to isolation protocols

(vi)    Unavailability of protective equipment

(vii)   Financial hurdles such as reduction of income or increased expenditure Healthcare professionals were subject to a greater amount of panic and therefore, they uncritically accepted the news items addressing strong negative consequences of COVID-19 due to confirmation bias (refer to section 5.1.2). The exposure to negative aspects of human society in the form of stigma and discrimination makes it imperative to study the effects of the infodemic on this highly vulnerable population.

Infodemics have always prompted stigma and discrimination amongst various ethnicities or classes of the profession. It is already insurmountably difficult to win the fight against the COVID-19 pandemic, the addition of infodemic into the mix only serves to add oil to the fire. In order to tackle the infodemic effectively, understanding its characteristics, influencing factors and countermeasures is of utmost importance, particularly the healthcare workers. Health literacy along with adequate training would empower the healthcare workers to effectively combat the infodemic while preserving their own mental well-being. Even so, not much has been studied regarding the characteristics and impact of the infodemic on the Indian population.